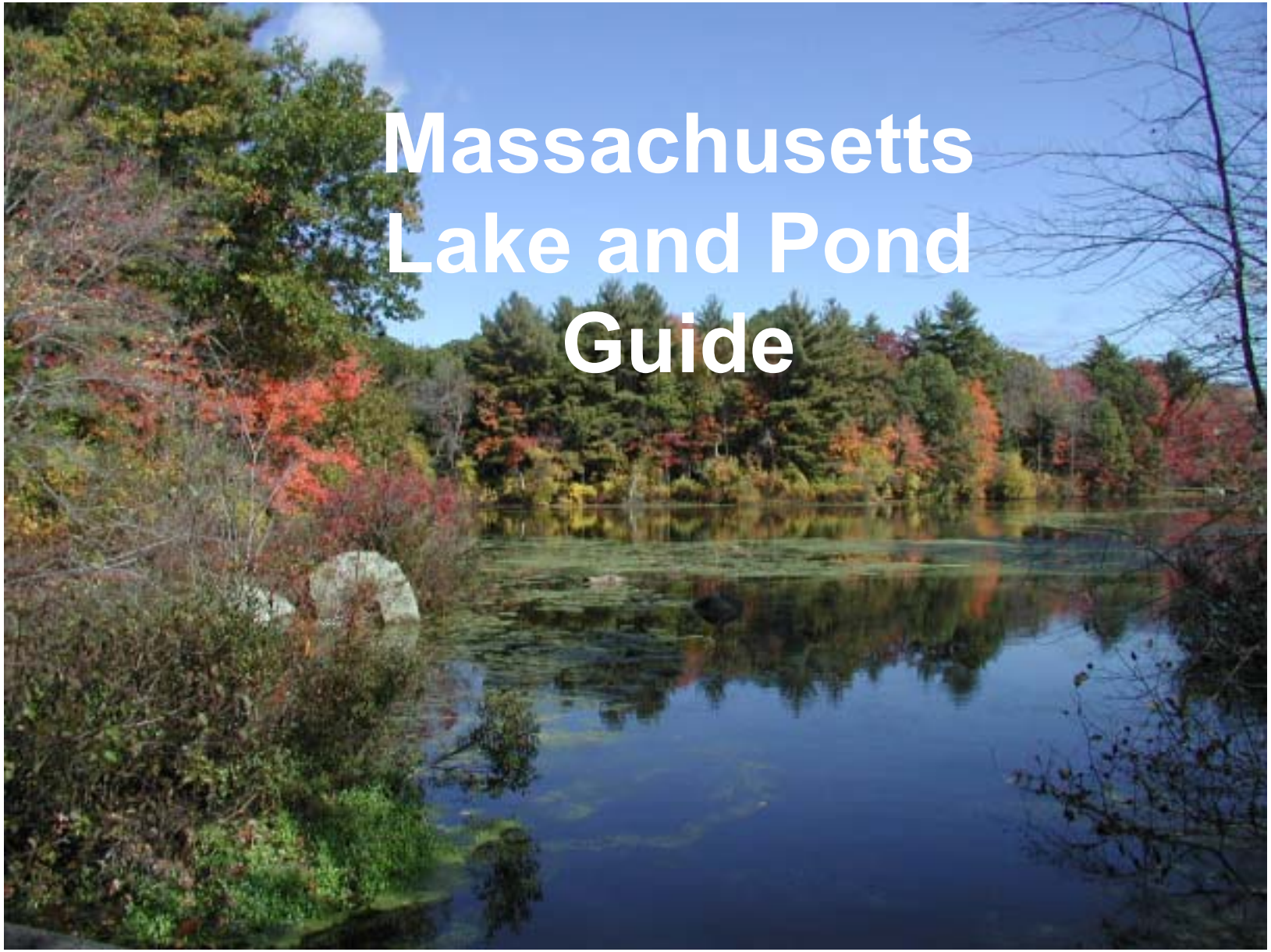
Massachusetts
Lake and Pond
Guide

Welcome to the Massachusetts Lake Book

Massachusetts has over 3000 lakes and ponds that provide opportunities for recreation and valuable habitat for a wide diversity of plants and animals. However, over the years, many citizens of Massachusetts have observed a decline in the health of their lakes and ponds. By choosing to read this book you are taking the first step towards protecting your lake or pond. This book is a starting point for concerned citizens who wish to learn about lake ecology and ways they can protect the future of their lake or pond.

The first two chapters will help you understand the basic concepts of watersheds and the ecology of lakes and ponds. It covers the importance of a watershed approach to lake and pond protection and the ecology and cycles within a lake system. The following chapters address the main causes of reduced water quality and outline ways that you, as a concerned citizen, can adopt a proactive role in preventing further degradation to our waterbodies. The last chapter provides guidance for people who wish to go one step further and begin or join a lake association, apply for grants or obtain additional education publications. Words in italics are defined in the glossary in the back of the book.

Act now and protect your lake's future!

Protect Massachusetts' Lakes

The water of our planet is stored in many areas.

94% fills our oceans,
2% remains trapped in glaciers and snow caps, 4% lies under ground, and only 0.1% of all the water on the Earth is fresh surface water.

It is crucial for citizens to work toward the protection of this precious and vulnerable resource.

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Introduction

In the 1800's, Henry David Thoreau, inspired by Walden Pond, wrote, "*A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature*." More than one hundred years later, residents and visitors continue to be inspired by the scenic lakes of Massachusetts. There are over 3,000 lakes and ponds in Massachusetts that provide drinking water, flood control, irrigation, electricity, aesthetic values, recreation and habitat for fish and wildlife. The lake environment creates a diverse habitat for wildlife and provides a home for hundreds of animals, including threatened species.

Today, the future of many of Massachusetts' lakes is at stake. Aquatic nuisance species, pollution, shoreline and watershed development and stormwater issues threaten the health of our lakes. In many lakes, the rate of *succession* has accelerated and is causing them to become "old" before their time. It is critical that citizens become involved and take an active role in improving the health of their lakes and protecting these valuable resources for future generations. This book was created to provide information and guidance for concerned citizens who wish to secure a safe future for their lakes.

Understanding Watersheds

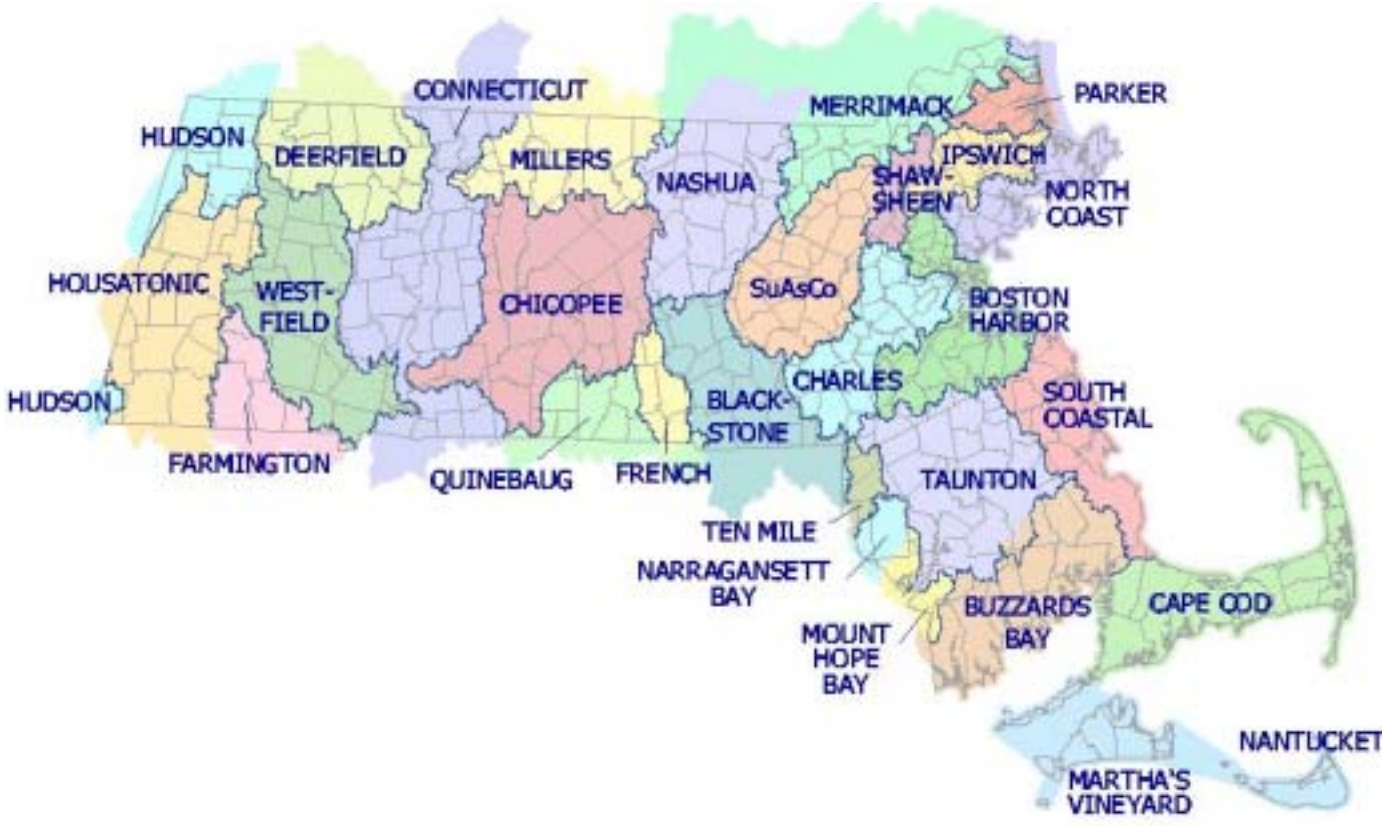
What is a Watershed?

A watershed is an area of land from which water drains into a particular river or other surface waterbody. The boundaries of a watershed are determined by higher areas of land, which separate it from adjacent watersheds. There are 27 watersheds in Massachusetts and within each of the major watersheds are the smaller watersheds of each lake or pond. Within each lake or pond's watershed all the water in that area flows to the lowest point and enters the lake or pond.

In Massachusetts, under natural conditions, approximately 50% of rainfall evaporates, 45% infiltrates back into the ground and only 5% is runs off overland. The 45% of precipitation that seeps down into the earth replenishes the ground water supply. In some areas where the soils are very sandy, such as Cape Cod, water moves primarily as *groundwater* because most of the water that falls on the ground soaks in quickly. Any pollutants or toxins that are not filtered out enter and contaminate the ground water. About 96% of all the drinkable water on the planet is stored in ground water and over half of all Americans rely on ground water for their drinking supply. Groundwater is primarily stored in aquifers and moves very slowly. Any toxins that enter the groundwater move beneath the earth as a toxic plume waiting to discharge into a lake, stream or well.

In other areas, where soils are less porous or where the land has been paved, less water soaks into the ground and water travels primarily over the surface as *run-off*. Since all the land in a watershed drains water into a lake or stream, every activity in that watershed ultimately has an effect on the lake or stream. Picture a drop of water falling near the summit of a mountain. As the droplet begins to travel down the mountainside it may pick up sediment and oil residue as it trickles over a road. The droplet continues to wind its way downward through a garden collecting pesticide residues, fertilizer and waste from a pet, and eventually enters a lake, stream or pond. This type of pollution is called *non-point source pollution* because the pollution did not enter the lake from a single identifiable location, such as a sewage pipe, instead, the pollution came from multiple locations. When trying to maintain a healthy lake it is important to monitor all the activities within the watershed and to prevent nutrients, such as phosphorus, sediments and other forms of pollution from draining into a lake. This topic is covered in greater detail in Chapter Three.

What is Your Watershed Address?



Massachusetts has twenty-seven watersheds.

Watershed Initiative

In October 2000, Secretary of Environmental Affairs, Bob Durand, convened a Blue Ribbon Committee of technical experts on lake and pond management, academic scientists, lake and pond association representatives, and state environmental agency officials to develop and implement a Lakes and Ponds Watershed Action Strategy for the Commonwealth of Massachusetts. The Committee's mission was to identify immediate actions that could be taken to improve lake and pond protection efforts and to integrate these efforts with the Massachusetts Watershed Initiative. The Blue Ribbon Committee endorsed the existing Lakes and Ponds Policy of the Commonwealth, which states:

Massachusetts advocates a holistic approach to lake and pond management and planning, which integrates watershed management, in-lake management, pollution prevention and education. Lake management in Massachusetts will be designed with consideration of the quality of the lake's ecosystem, its designated uses and other desired uses, the ability of the ecosystem to sustain those uses, and the long term costs, benefits and impacts of available management options.

The purpose of the Lakes and Ponds Watershed Action Strategy is to rally the full range of stakeholder groups, who take responsibility for and enjoy these valuable resources, in support of lake and pond protection and restoration. The Lakes and Ponds Watershed Action Strategy will build on the Massachusetts Watershed Initiative by fully integrating lakes and ponds into the watershed approach for environmental protection and restoration.

Lake & Pond Basics

- Formation of Massachusetts' Lakes
- Hydrological Cycle
- Effects of Solar Radiation
- Oxygen & Nutrients
- Understanding pH
- Living Components
- Eutrophication/Enrichment
- Laws That Protect Your Lake

Lake Formation

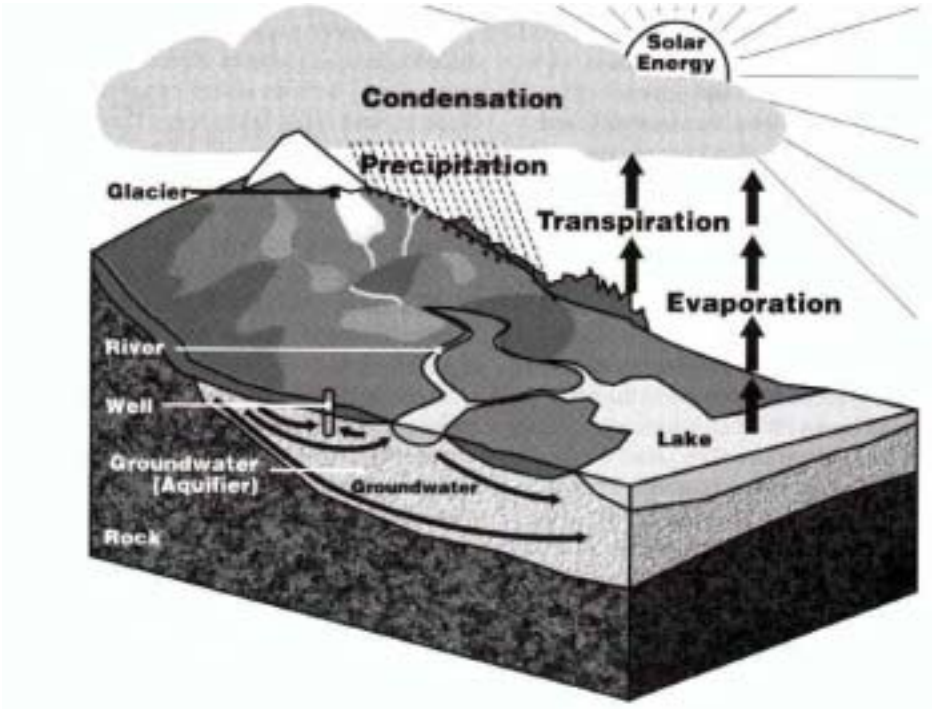
Lakes are formed in a variety of ways, including: fluvial activity (river activity), tectonic land movements, volcanoes and glacial activity. Most of Massachusetts' lakes were formed 10,000 to 20,000 years ago at the end of the last ice age. The glaciers carved deep holes and gouges in the surface of the earth and glacial moraines that remained dammed the rivers and streams to create some lakes. Kettle ponds, commonly found in the southeast part of the state, including Cape Cod, were created when ice chunks were buried and later melted.

In recent years, human and animal activity has resulted in the creation of new lakes and ponds. Dams have been constructed by humans to provide irrigation for crops, reservoirs, roads and hydroelectric power. Beavers also create dams across streams, forming temporary ponds. Lakes are constantly changing as sediments and organisms slowly fill in the basin and changes occur in the succession of plants and animals.

Hydrological Cycle

Water enters lakes and ponds in a variety of ways, but precipitation is the largest factor determining most lake levels in Massachusetts. A large portion of precipitation re-enters the atmosphere through evaporation and transpiration of plants. Some rainfall flows overland as storm water runoff through one of the 27 watersheds in Massachusetts to enter streams and lakes. A portion of precipitation soaks into the ground and travels beneath the surface as groundwater.

Changes on the earth's surface, including paving and construction, alter the amount of rainfall that can filter down in the soil to refill the water table, thus effecting the hydrology of the area. Although dams can help maintain water levels, fluctuations in the lake levels are normal. The underlying geology of a lake is another important factor in determining the source of water to lakes. The properties of the underlying bedrock determine whether water will seep down into the water table or be retained in the lake.



Solar Radiation

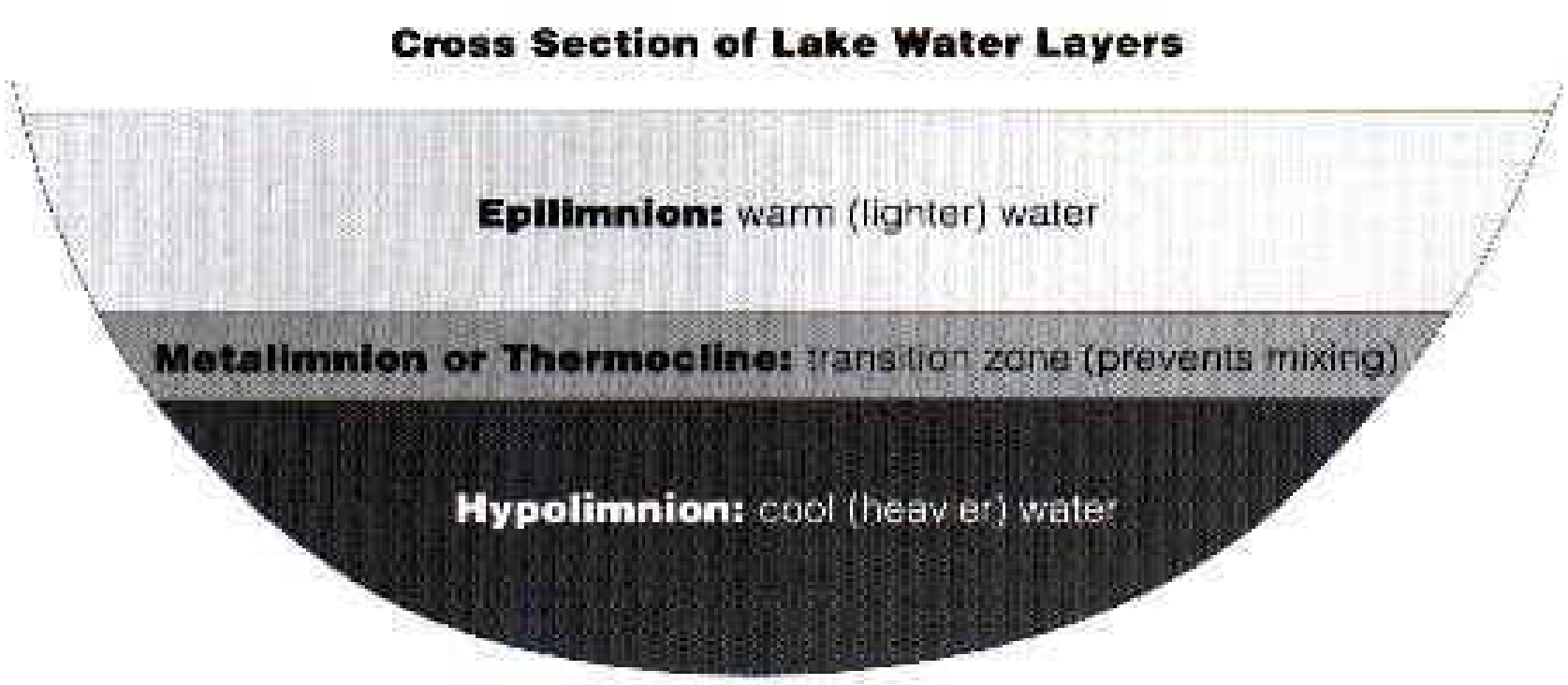
Solar radiation affects a lake in many ways: warming water to create thermal stratification and seasonal “circulation”, creating the wind patterns that mix lake waters and providing energy for photosynthesis.

Thermal Stratification

During certain seasons deeper lakes have thermal layers within them due to temperature variations in the water. Stratification is a reflection of the variations in water density. The density of water changes with temperature; usually, cooler denser water sinks, warmer water rises. During the spring, lakes thaw and the surface water is warmed. Eventually this warmer water mixes with deeper waters and creates a spring turnover *or circulation period*. The stratification becomes more defined as summer progresses and three distinct layers develop in ponds with adequate depth (See diagram). The top layer, or *epilimnion,* is the layer of greatest productivity due to warmer temperatures and abundant light. The middle layer, called the *metalimnio*n, has a rapid temperature change that helps to form a physical barrier, called the *thermocline*, between the top and bottom layers. Although the barrier is not visible, the difference in the water densities is strong enough to prevent mixing of water, chemicals and gases (including dissolved oxygen) between the upper and lower layer. The waters in the deepest layer, the *hypolimnion*, are relatively cool, usually with lower dissolved oxygen and little light. When you dive down into a thermally stratified lake or pond you may feel the changes in temperature as you pass through the three thermal layers. During the fall, the layers dissipate as the surface water cools and eventually the layers mix together.

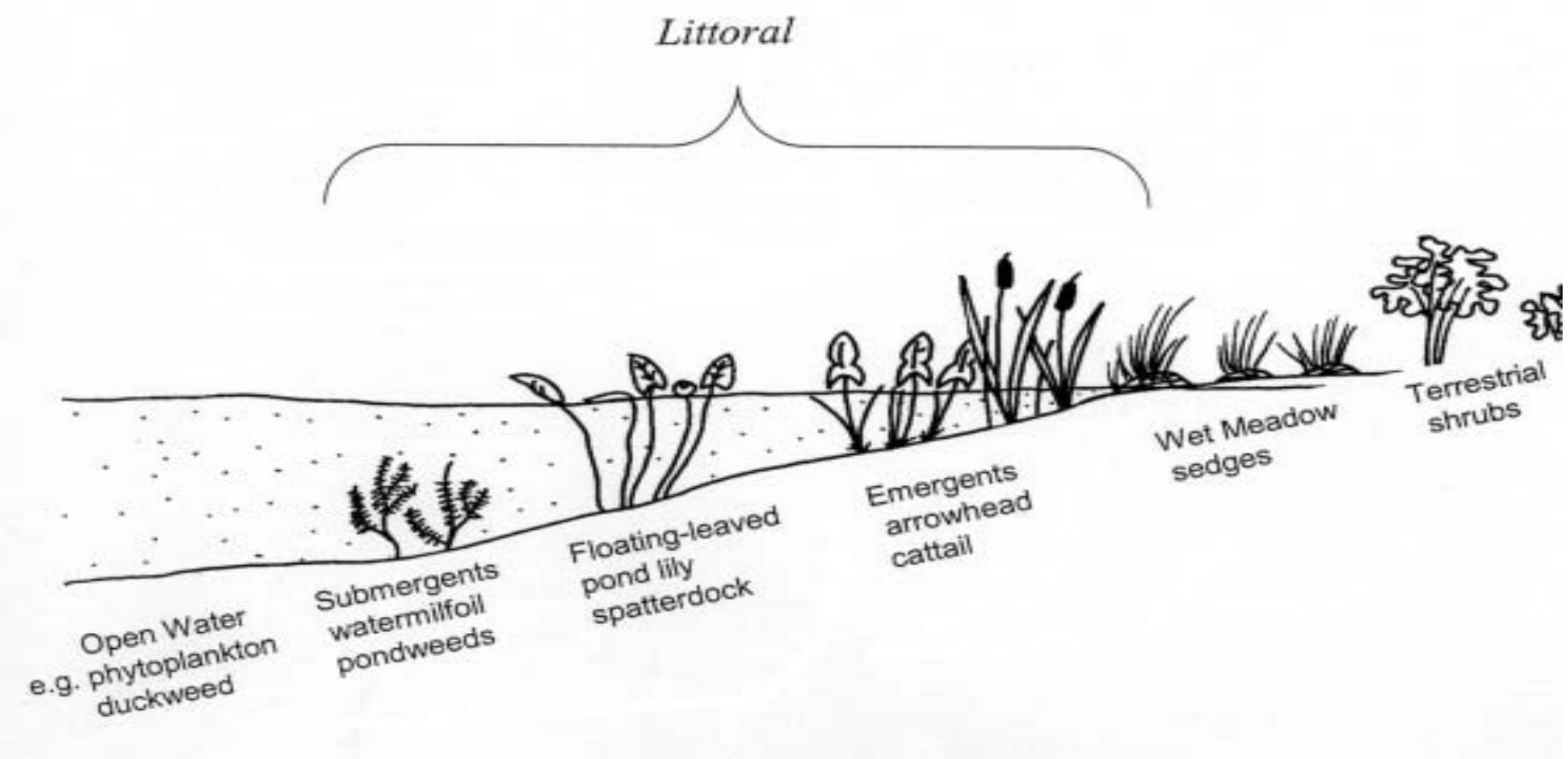
Thermal Stratification Diagram

Epilimnion: warmer well-mixed, well lit waters, with adequate dissolved oxygen.
Metalimnion/Thermocline: Area of rapid temperature change that forms a barrier to prevent the upper and lower waters from mixing.
Hypolimnion: Bottom layer of cooler, heavier and darker waters. This layer may have little dissolved oxygen during the summer. Due to lack of light, plants do not grow (thus release) oxygen in this layer.



Light Zonation

Light is critical for *photosynthesis* in plants. Photosynthesis is the process by which plants convert carbon dioxide and light to energy and release oxygen. Photosynthesis can only occur where there is light, so plant growth is limited to the *littoral zone* of the lake (see diagram). The well-lit *photic layer* of the lake includes waters down to the point where light dims to 1% of the light at the surface. In the *aphotic zone* light levels are too low for photosynthesis to occur, however, *respiration* continues at all depths, so the aphotic still consumes oxygen but does not produce any.



Oxygen

Most aquatic organisms require oxygen to live and the amount of dissolved oxygen in the water often determines where organisms can be found. In *temperate lakes*, during the summer months, very little oxygen is present in the hypolimnion, the deepest layer, because the decomposition of plant and animal material may use up the available oxygen. When water has less than 0.5ml/l dissolved oxygen (DO) it is called *anoxic* and fish cannot survive this condition. Cold water fish, such as trout, may be forced to move up into the warmer yet oxygenated waters, where they may become stressed and die. During the fall circulation period, when the temperature layers break down, oxygen is returned to the deeper layers. As winter arrives and an ice barrier forms over the surface, the oxygen supply in the lake begins to decline, but usually to a lesser degree.

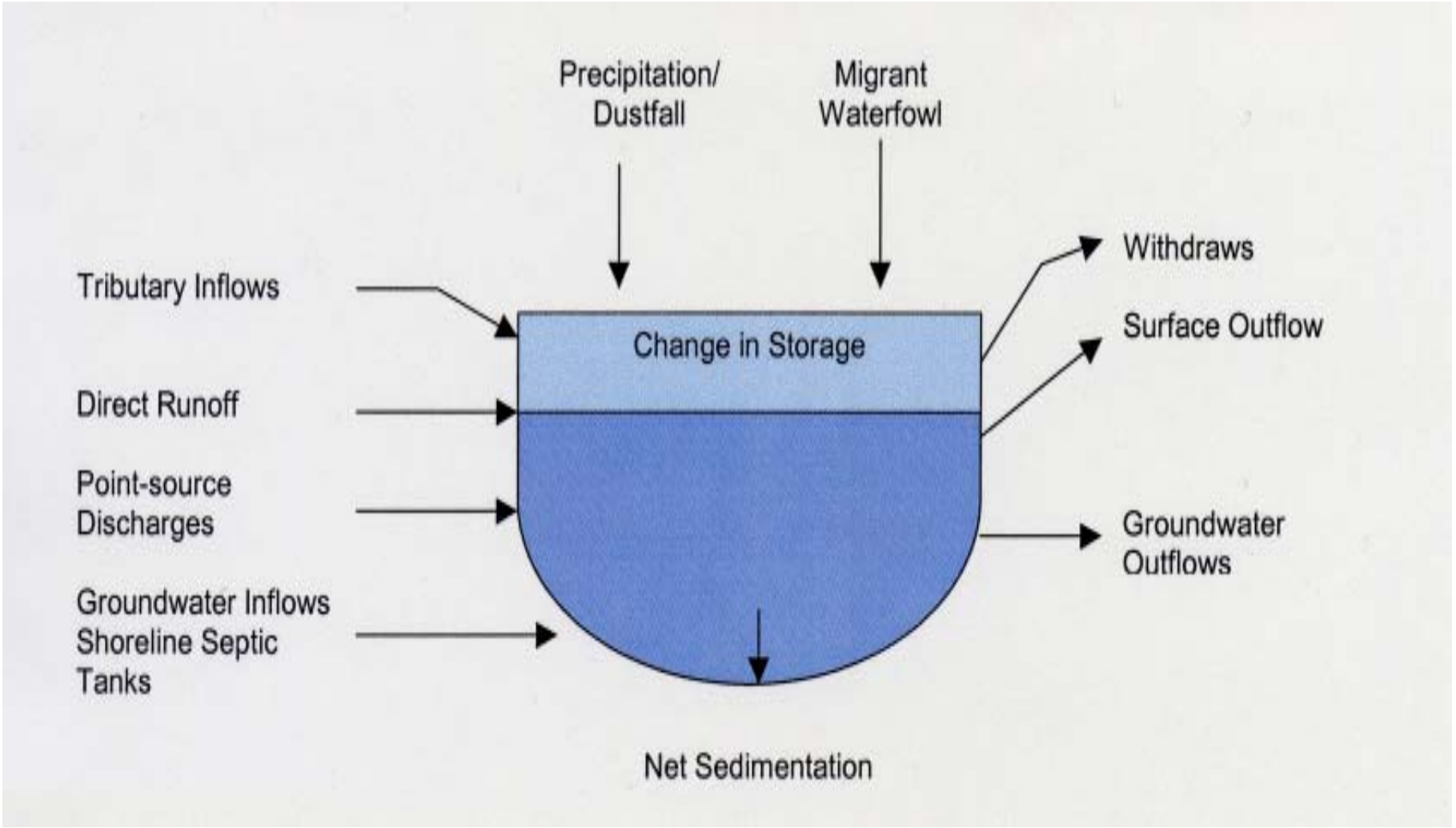
Nutrients in a Lake

The two key nutrients that determine the algae and vegetative growth in a lake are nitrogen and phosphorus. Since phosphorus is relatively scarce in most inland freshwater systems, its quantity determines the amount of plant growth.

Phosphorus

Phosphorus is generally not available in the environment because there is a relative lack of phosphorus-containing materials. Phosphorus has no atmospheric gaseous phase and it is tightly bound by many organic sediments, and is therefore unavailable for uptake by organisms. When one nutrient is not as readily available as other nutrients it is called the limiting nutrient because its availability determines plant growth. Although phosphorus is relatively rare, human sources such as fertilizer, sewage and eroded soil can overload lakes with available phosphorus. Excess phosphorus introduced to a lake provides food for plants and algae and can increase the vegetation growth within a lake. Large concentrations of phosphorus may create *algal blooms*, which turn the waters murky, kill fish and diminish the lake's recreational and aesthetic appeal. The decaying algae and plants eventually die and sink to the lake bottom where oxygen is utilized as they decompose. As the already low oxygen levels in the hypolimnion decline, the phosphorus once trapped in the sediment is released, increasing the availability of phosphorus to the lake system.

Phosphorus Budget Graph



Nitrogen

Nitrogen is the fourth most common cellular element necessary for plant growth. Nitrogen is readily available to plants from several sources. First, the atmosphere consists of approximately 72% gaseous nitrogen (N2) and blue green algae can convert N2 to a form that is useable for other plants. In addition, nitrogen moves rapidly through soils and is quickly converted from one form to another by nitrifying bacteria. Human sources of nitrogen include fertilizers, acid rain human waste and changes in the surrounding vegetation due to fires, floods or clearing.

Other Nutrients

Other nutrients including iron and sulfur, are essential cellular constituents that are needed in low concentrations. Sodium and potassium are required in small amounts, and calcium plays a critical role in determining the hardness and pH of the lakes water. The composition of the soils and bedrock in the surrounding watershed determine the amount of calcium that enters the lake via storm water runoff. Aquifers rich in limestone minerals can also supply lakes with calcium.

Understanding pH

pH is an expression of the amount of hydrogen ions (H+) in the water. A pH 7 (ex. distilled water) has equal amounts of hydrogen (H+) and hydronium (OH-) ions. As the amount of hydrogen ions increases, the pH reading is lower and the water is considered more acidic. Conversely, when the quantity of hydrogen ions decreases, the pH reading is higher and the water is more alkaline. (see illustration below) A change in 1 on the pH scale represents a tenfold difference in the amount of hydrogen ions in the water. For instance, a lake with a pH 6 is *ten times* more acidic that a lake with a neutral pH 7.

acidic 1 2 3 4 5 6 7 8 9 10 11 12 13 14 alkaline

One way acid rain is forms is when moisture and carbon dioxide mix in the atmosphere. On average, acid rain has a pH of 5.6, which is lethal to many aquatic organisms and can inhibit spawning in some fish species. In addition, as water becomes more acidic, the level of several toxic chemicals, including mercury increases. Mercury does not necessarily kill fish, instead it bio-accumulates and remains stored in the tissue and over time becomes increasingly concentrated. Humans and animals that consume mercury-laden fish may face serious health risks. The increase of mercury in acidic lakes has been cited as one of the causes for the decline in osprey and eagles.

Lakes vary in their ability to buffer acid rain. The calcium carbonate system in a lake determines its ability to neutralize acid. The presence of calcium carbonate ($CaCO_3^-$) and calcium bicarbonate ($H_2CO_3^-$) raise the hardness and pH of the water, thus reducing the harmful effects of acid rain. As mentioned before, the level of calcium in a lake is dependent on the surrounding watershed and from the other sources of water (such as aquifers or streams) that feed the lake.

Living Components

Phytoplankters

Phytoplankters are free floating microscopic algae that are a source of food for other organisms, produce oxygen as a byproduct of photosynthesis and they presence can affect the taste, color and odor of the water.

Zooplankton

The second group of organisms, the zooplankton (from the Greek word “wanderer”), are free floating or weakly swimming microscopic animals at the mercy of the wind and waves. Zooplankton are important because they are a bridge between the base of the food chain and the higher trophic levels. Zooplankton are the primary consumers and graze heavily on the phytoplankton. I turn, the zooplankton population is controlled by fish and other animal predation.

Plants

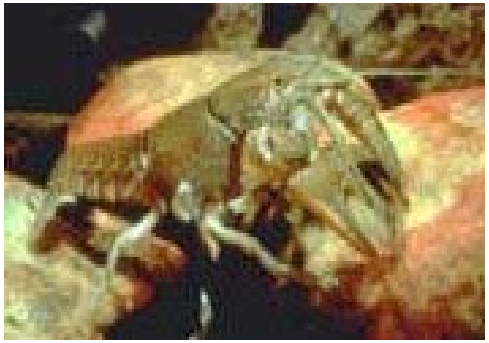
The rooted plants that thrive along the edges and in the littoral zone are called macrophytes. These plants are divided into three main groups: submerged, floating-leaved, and emergent. Native aquatic plants are important in the ecological balance of lakes because they provide oxygen, food, habitat, shelter and contribute to the diversity of the aquatic environment. In addition, their roots help stabilize the shore and slow the flow of sediments and pollutants into the lake.

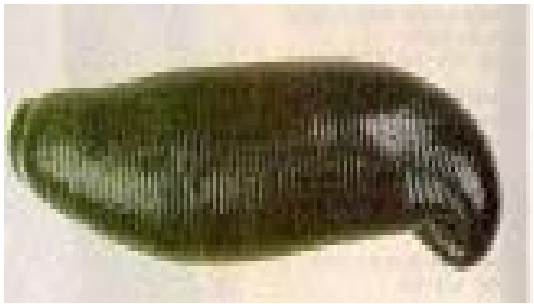
Macroinvertebrates

The macroinvertebrates are another source of food and they process energy in the ecosystem. Many of these animals are found in the benthic zone (or bottom layer) of the lake, and their tunneling activity helps to release nutrients from the sediments. This group includes immature dragonflies, mayflies, beetles, snails, leeches, crayfish and bivalves.

Bacteria

Bacteria are single celled organisms that breakdown and decompose matter within a lake's ecosystem. Although most bacteria are beneficial, a few, such as Giardia, can be harmful to humans.





Fish

Fish are cold blooded animals and comprise 40% of all the vertebrate species on earth. The great variety of fish enhance the biodiversity of the aquatic system and they play a major role in the food chain. Fish are often categorized based on their water temperature requirements. Cold water species, such as trout and salmon, prefer more pristine water conditions with cool temperatures and high dissolved oxygen. As the trophic state of lakes shift (see next section), warm water fish, including bass and carp, are supported. These species are more tolerant of decreased clarity and lower levels of dissolved oxygen and can withstand warmer temperatures.

Reptiles and Amphibians

Other wildlife found in and near lakes and ponds include many species of amphibians and reptiles. Amphibians and reptiles are also cold-blooded animals. Amphibians, such as frogs and toads, are dependent on water for at least one stage of their life cycle. In the spring they reproduce and lay eggs in the water. The eggs hatch into a larval stage (tadpoles) which develop adaptations for living on land as they mature. Reptiles are independent of water for reproduction and lack a larval stage. However, many reptiles including turtles and snakes, make their homes in and around lakes and ponds.

Birds

Most birds have developed adaptations for flight and species, such as ducks, geese, cormorants and herons have adjusted to a mainly aquatic life. Massachusetts has a variety of waterfowl that thrive in the aquatic environment.

Mammals

Many mammals including otter and beaver live in lakes and ponds. These mammals hunt for fish and fresh water bivalves, retreat to the water for safety and create homes out of branches and mud.

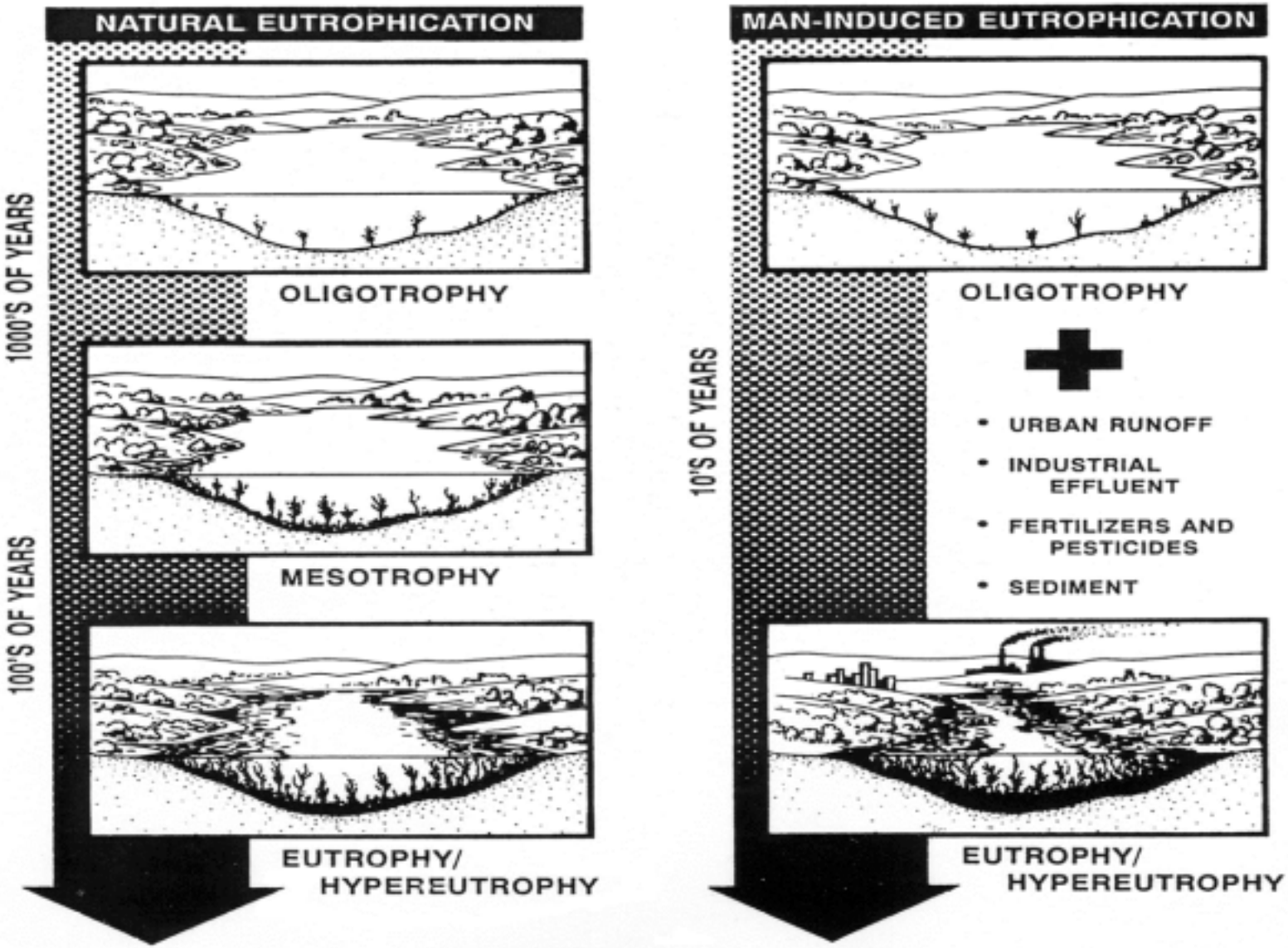
Eutrophication & Enrichment

Natural Enrichment

"Lakes are destined to die" is a phrase commonly used by *limnologists* to describe the process of *succession*. Lakes are constantly changing as sediments and decomposing organisms slowly fill in the basin and changes occur in the succession of plant and animals. Lakes usually start out in an *oligotrophic* (nutrient poor) state and progress towards a *eutrophic* (nutrient rich) state. (see diagram next page) A classic example of an oligotrophic lake is Walden Pond in Massachusetts. These types of lakes tend to have clear water, barren basins and little aquatic plant growth. As time progresses, silt from rivers and decaying organisms begin to fill in and enrich the lake. Plants start to take root, organisms that feed on algae and plants increase in number, and the lake becomes more biologically complex. Gradually, the succession of plant and animal communities shift as the once clear lake moves toward a more nutrient enriched, *mesotrophic* state. Most lakes in Massachusetts are considered to be mesotrophic or eutrophic. As nutrient levels continue to increase, the lake enters a *hypereutrophic* marsh like state. Lake depth, nutrient levels in the surrounding watershed, and erosion rates are all contribute to the successional process of a lake.

Cultural Eutrophication

A lake's succession usually takes thousands of years, but human activity often accelerates the process. The process by which a lake receives unnaturally higher amounts of nutrients is called *cultural eutrophication,* and human activities are the usual causes of this. Phosphorus from fertilizers, sediments from run-off, urban development, land clearing, recreation and septic waste all expedite the level of eutrophication. Chapter Three describes some of the issues that affect the level of eutrophication and how concerned citizens can adopt a proactive stance towards protecting their lakes.


NATURAL EUTROPHICATION
1000'S OF YEARS
OLIGOTROPHY
MESOTROPHY
100'S OF YEARS
EUTROPHY/
HYPEREUTROPHY
MAN-INDUCED EUTROPHICATION
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OLIGOTROPHY
• URBAN RUNOFF
• INDUSTRIAL EFFLUENT
• FERTILIZERS AND PESTICIDES
• SEDIMENT
EUTROPHY/
HYPEREUTROPHY

Lake Issues & Management

- Stormwater
- Invasive Species
- Algae
- Bacteria
- Common Lake Questions
- Watershed Controls
- In-lake Restoration Techniques
- Aquatic Plant Control Techniques

Stormwater Issues

One of the greatest threats to the quality of water in our lakes and ponds and the health of the aquatic environment is stormwater pollution. When it rains or snows, the water rushes over highways, parking lots, streets and lawns and collects nutrients, oils, toxins, sediments and other pollutants. This untreated water flows into storm drains and frequently empties into our lakes or ponds. Stormwater poses a greater threat to water quality in urban and agricultural areas than in undeveloped lands. In forested areas, the earth absorbs most of the stormwater and the soil and vegetation filters out pollutants. In developed areas there is a larger percentage of impervious surfaces, including pavement, roofs, and asphalt, which prevent water from soaking into the ground. As a watershed becomes increasingly developed, the percent of land that is covered by impervious surfaces increases and more stormwater runs off into receiving waterbodies. Storm water is an example of *nonpoint source pollution* because the pollution comes from a very broad area rather than a single identifiable source such as a pipe. Nonpoint source pollution is harder to control because it results from many activities that occur in our watersheds, including development, fertilizing, and other human activities. In addition, rain absorbs pollutants from the atmosphere and deposits them on the ground or in waterbodies.

Point Source Pollution

vs.

Non-point Source Pollution

Contaminants in Stormwater

Stormwater can carry a variety of contaminants that may degrade the receiving waterbody including: nutrients, sediments, bacteria, metals, toxic substances, trash, and warmer water with low dissolved oxygen.

Nutrients:

Excess levels of phosphorus and nitrogen are introduced to waterbodies from a variety of sources including failing septic systems, sewer overflow, urban stormwater runoff (carrying detergents, fertilizers, organic debris) and atmospheric deposition from industry and automobiles. Phosphorus is relatively rare in lakes and ponds and therefore, the level of available phosphorus controls the amount of plant growth. When additional large amounts of phosphorus are introduced to a waterbody, algal blooms may result. The decomposition of algae utilizes the available oxygen and fish often perish as the oxygen level drops. In addition, many toxins and pollutants are released from the sediments and become more water soluble under low oxygen (anoxic) conditions. Excess nutrients also accelerate the rate of eutrophication.

Sediments:

Sediments from a variety of sources are carried via storm water runoff into waterbodies. Although most sediments come from construction and agriculture, there are also many urban activities including winter road sanding, landscaping, loss of vegetation (which leads to erosion) and the development of new drainage pathways, which can be a source of sediments. Increasing the load of sediments into a lake or ponds has many harmful effects. The sediments slowly fill in the lake basin, causing the lake to become increasingly shallow and less capable of retaining and storing floodwaters. Sediments and shallow water can trap solar radiation, which increases water temperature while simultaneously decreasing the water clarity, and the breakdown of organic particles in the sediments can also deplete the available oxygen in a lake. This negatively impacts cold water fish that are dependent on cool, clear, oxygenated waters. Suspended sediment particles reduce light transmission, which may negatively impact the plant growth that bass and other fish require for shelter.

Contaminants in Stormwater Cont…

Bacteria and Pathogens: Many disease causing organisms can be carried via storm water runoff into lakes and ponds or when they are accidentally released from failing septic systems, agriculture waste, animal waste from pets or wildlife, and wastewater treatment plants. Although most bacteria are beneficial, some strains of bacteria can cause disease, alter the color, taste and odor of the water or force swim beach closures.

Metals*:* Metals pose a serious risk to our lakes in ponds, as they can be highly toxic to humans and aquatic animals. Metals from industry and commercial waste materials, atmospheric deposition, mining and automobile emissions all contribute metals to waterbodies. Some metals found in stormwater include copper, zinc, lead, chromium, and cadmium. Metals can accumulate in animal 's tissue and increase in concentration over time (bioaccumulation) leading to impaired reproduction, growth and development or even death. Humans who consume fish with accumulated level of mercury or other toxic metals are also at risk.

Oils and Grease: Oils and grease from vehicles build up over time on the surface of the roads. During a rainstorm, water washes these toxins off the road and carries them to nearby storm drains where they are transported to nearby waterbodies.

Pesticides/Organic Compounds/Salts: Oil leaks, pesticides, road salts and other toxic compounds are often spilled or incorrectly disposed off, and then are carried via storm water runoff to lakes and ponds. These compounds can reduce oxygen levels in a lake and are often lethal to juvenile fish or sensitive organisms. Many of these contaminants affect groundwater and other drinking water supplies.

Litter: Plastics, organic litter, and other toxic debris often degrade lakes and ponds when they are carried by stormwater into the waterbody. Not only does the aesthetic appeal of the lake decline as trash accumulates, but animals can become entangled in the debris and the breakdown of certain products release toxins into the water column.

Warm Water/ Low Dissolved Oxygen: Stormwater is often heated as it flows over surfaces that have been warmed by the sun, and consequently may increase the water temperature of the receiving lakes and ponds. Warmer water holds less oxygen and can raise the lake's temperature to the point that cold water species, including trout and salmon, become stressed and die. In addition, elevated temperatures often accelerate the breakdown of toxic substances and the release of contaminants from the soil.

Invasive Species

What is an Invasive Species?

Many plants that are found in Massachusetts were originally brought here from other places around the world, and these plants are called *non-native* or *exotic*. Although many non-native species such as Purple Loosestrife (right photograph) are beautiful, they can be extremely destructive to the environment because they disrupt the delicate balance of the ecosystem. Some exotic species are harmless, but others can have a very detrimental impact on the environment by out-competing native species and taking over the waterbody. Once a species, native or non-native, dominates or disrupts the biological community, it is considered *invasive*.

How did exotic species arrive here?

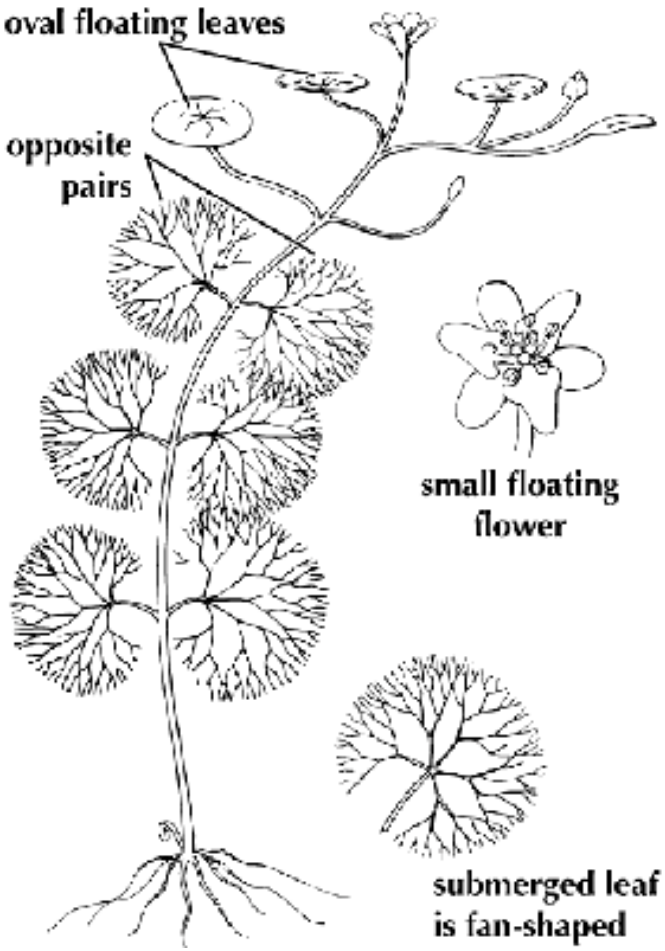
Exotic, or non-native species have been introduced to Massachusetts in a variety of ways including unintentional introduction in ship ballast water and accidental release through the aquarium or water garden trade. Some were deliberately imported and planted as colorful additions to gardens and ponds.

Why are they harmful?

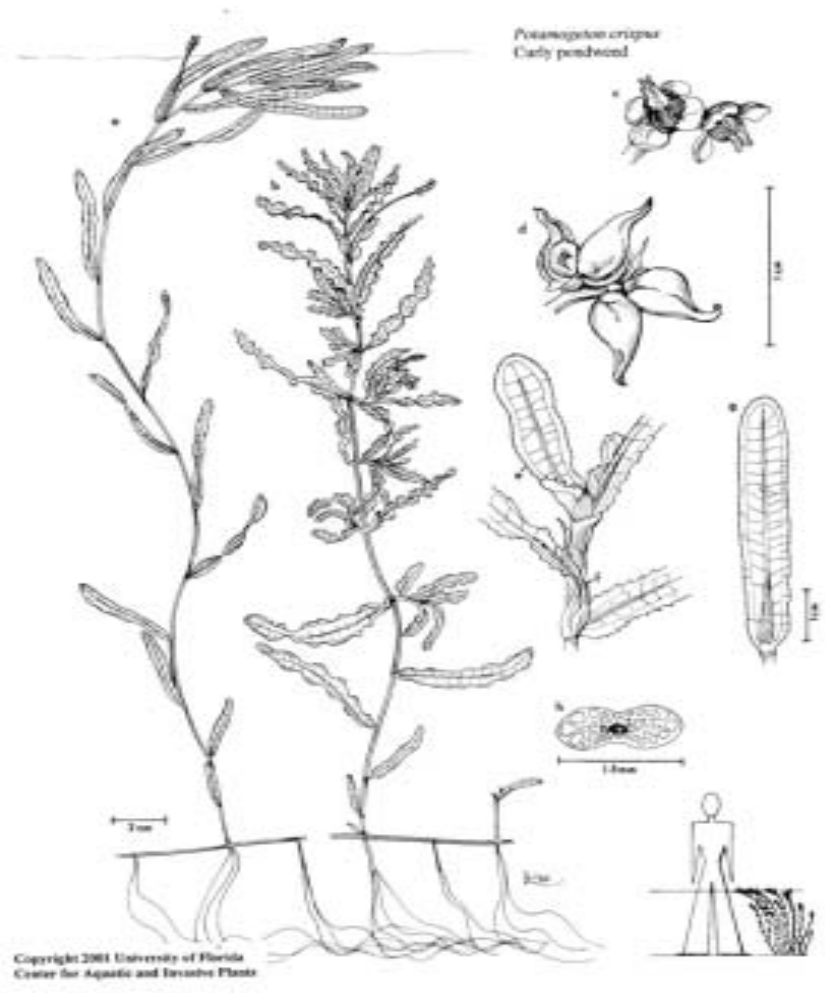
Since exotic species originated in other regions, most have not evolved natural predators in this region to keep their populations in control. In recent years, exotic invasive species have been spreading throughout Massachusetts' lakes at an alarming rate. Invasive species out-compete other species for space, light and nutrients. Since exotic invasive plants often do not provide ideal sources of food and shelter, as native plants die, many of the animals that were dependent on native plants must attempt to relocate or they may perish. In essence, invasive species often create single species stands, thus reducing biodiversity. Once established in a lake they are almost impossible to eradicate, and managing them is very costly. Invasive species can impede recreational activities and in cases when dense mats have formed, boat navigation is no longer possible (see center photograph). In addition, infestations of invasive species can lower property values, decrease aesthetic value, restrict movement of vertebrates, stunt fish growth, displace wildlife and in some cases damage docks, dive gear and boat motors.

What is being done to control invasive species?

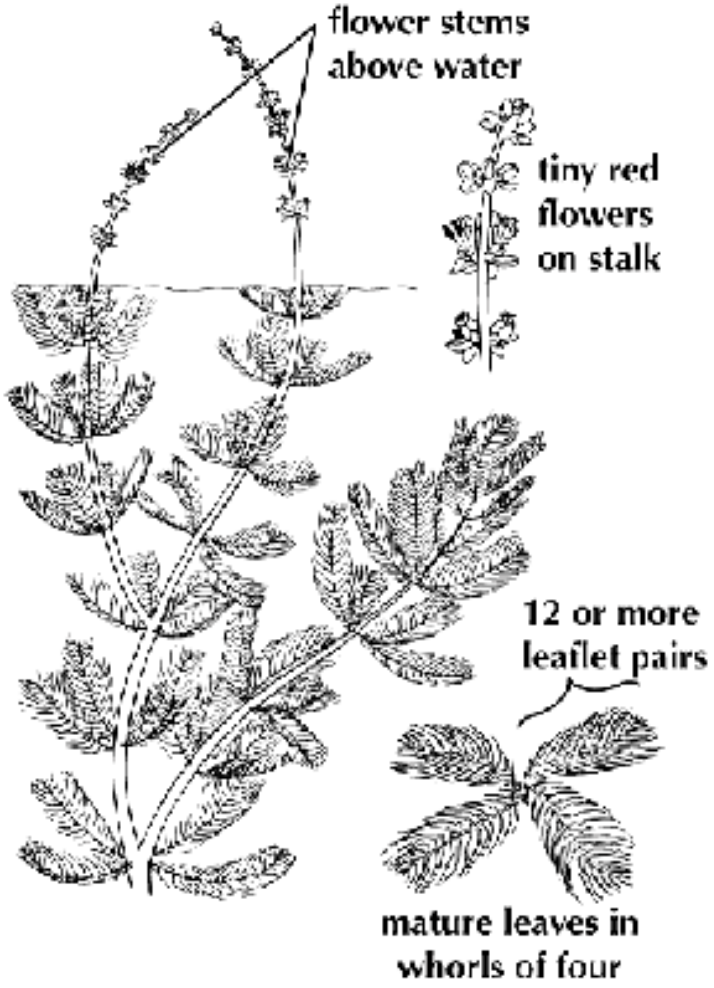
The best method for controlling exotic invasive plants is to prevent them from becoming established in a waterbody. The Department of Environmental Management's Lakes and Ponds Program has developed a Weed Watcher Program for early detection, handing out informative brochures and placing educational signs at boat ramps. Massachusetts is an active member of the Aquatic Nuisance Species (ANS) regional task force, which is a federally funded program working to develop tighter regulations on the sale and transportation of invasive plants and to promote education.

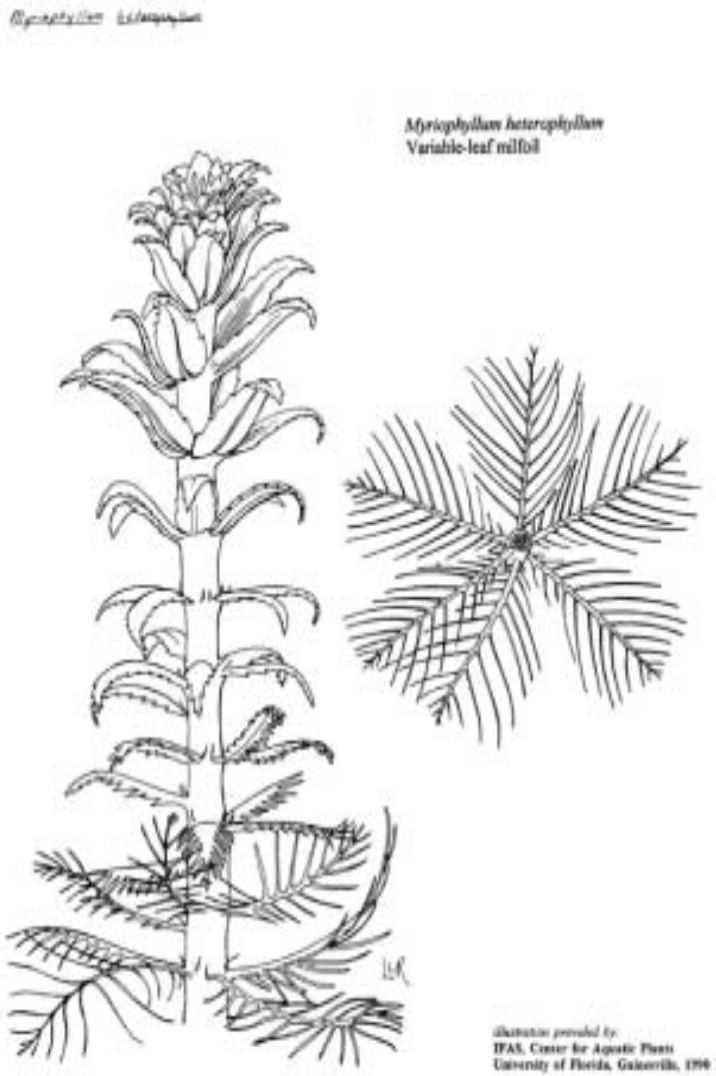


Fanwort (*Cabomba caroliniana*)

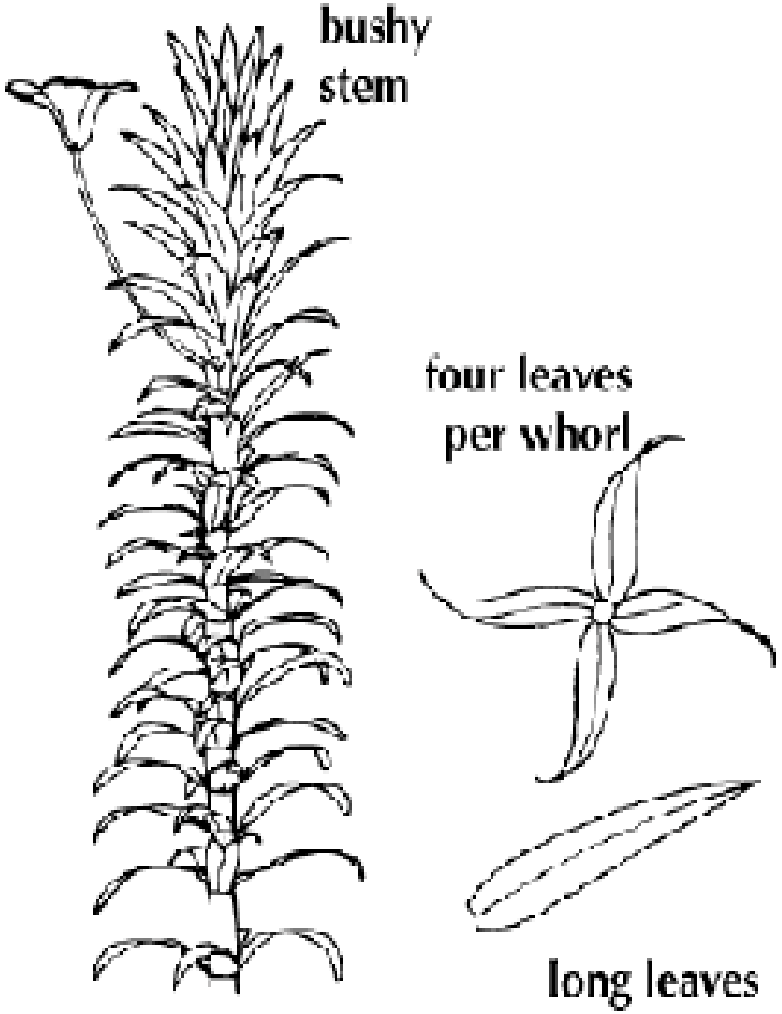


Curly-leaved Pondweed (*Potamogeton crispus*)

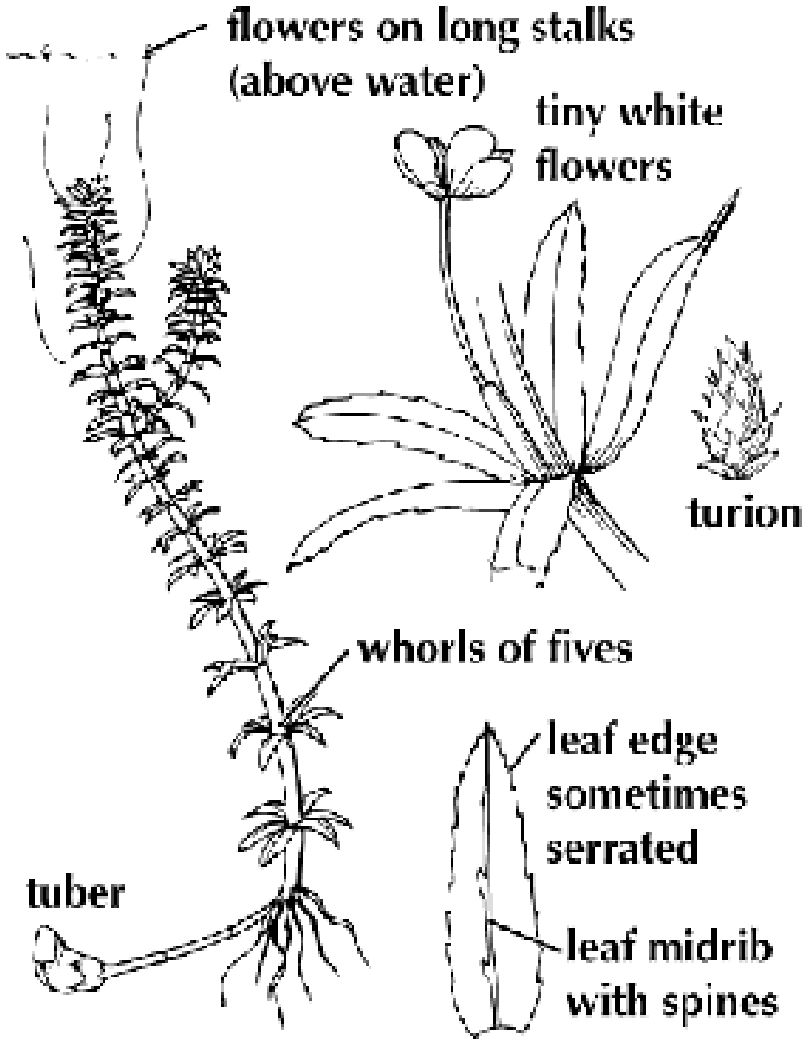




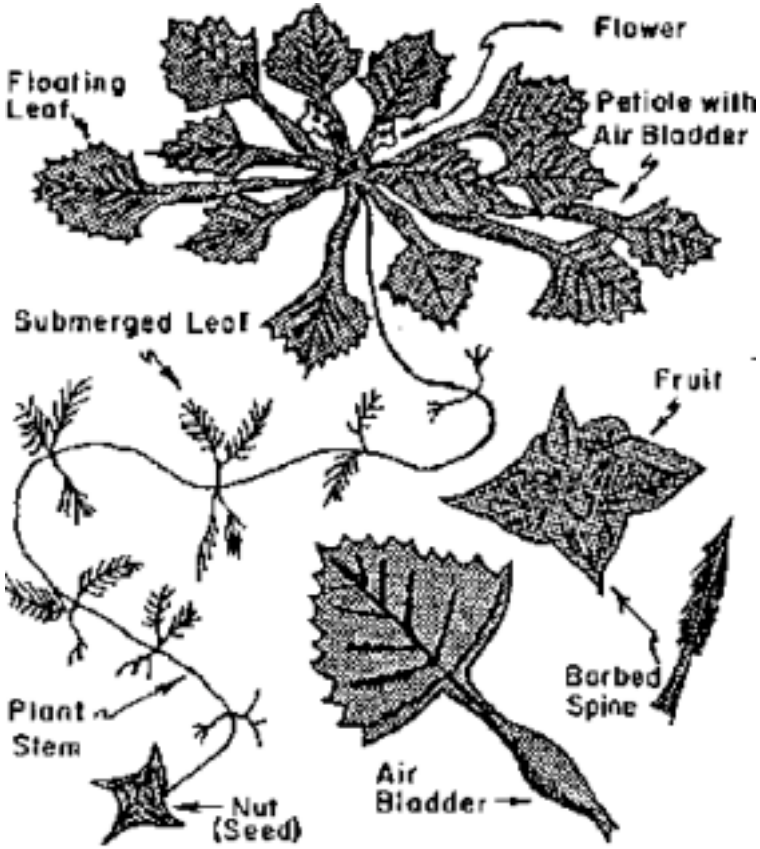
Eurasian Milfoil (*Myriophyllum spicatum*) **Variable Milfoil** *(Myriophyllum heterophyllum)*



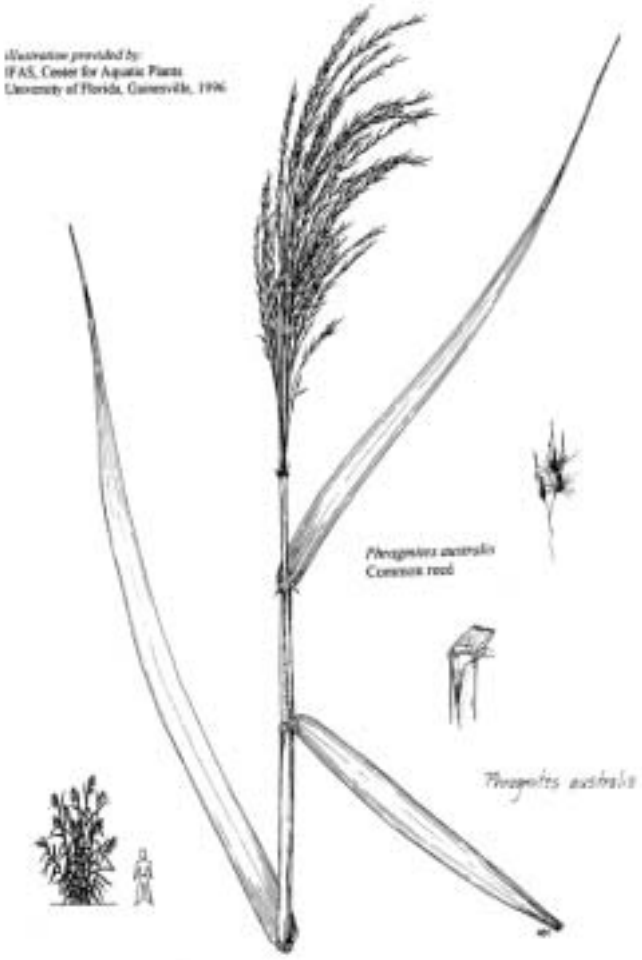
South American Waterweed (*Egeria densa*)



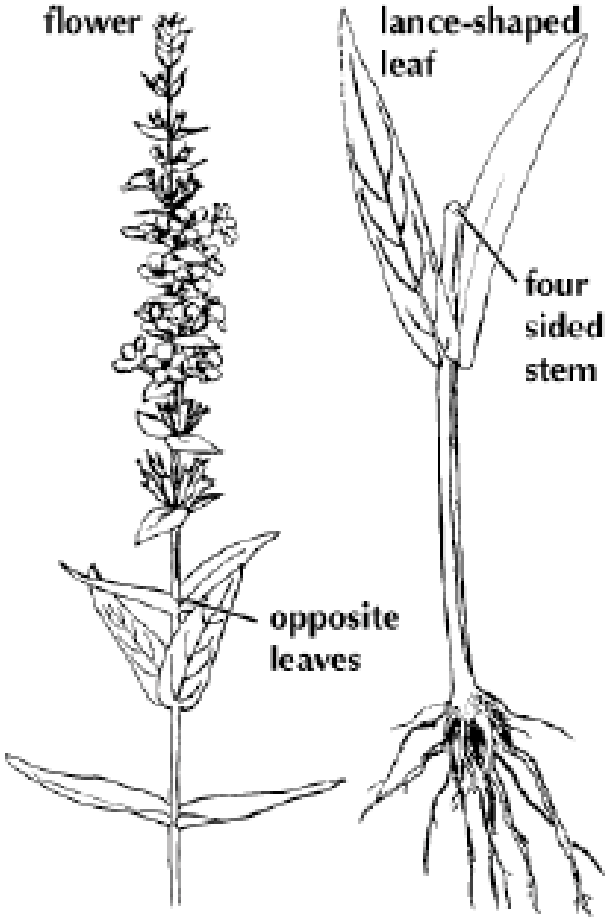
Hydrilla (*Hydrilla verticillata*)



Water chestnut
(*Trapa natans* L.)



Common Reed (*Phragmites australis*)



Purple Loosestrife (*Lythrum salicaria*)

Asian Clam

Spiny Waterflea

Potential Threats

There are several invasive species including the Asian Clam, Zebra Mussel, Spiny-tailed Water Flea, Parrot Feather and Flowering Rush that have not yet invaded Massachusetts. The Zebra Mussel can be found in neighboring states and threatens to enter our state in the near future. It is important to learn to recognize these species and always remember to inspect your boat motor, trailer, bait buckets and gear to prevent their spread to Massachusetts water bodies.
If you find any of these species, please report the sighting to:

Massachusetts Department of Environmental Management
Lakes and Ponds Program
1-617-626-1382

Zebra Mussel

Parrot Feather

Stop the Spread of Aquatic Invasive Species!

Boaters:

•Remove all plant parts from your boat motor, trailer, anchors, fishing gear and dive gear.

•Dispose of plant matter on dry land away from shore or in a trash can.

•Dispose of live well, bait and cooling water away from the shore after each use.

•If you are leaving a waterbody known to be infested, wash your boat with hot water and allow it to completely dry before entering another body of water.

•Never release a species into a body of water unless it came out of that body of water.

Everyone:

•Help spread the word and inform others about exotic invasive plants.

•Join the Massachusetts Weed Watchers program and help identify and eradicate new infestations in your lake before they become permanently established.

•Request a free “Stop the Spread of Invasive Weeds” sign for your boat ramp from the Department of Environmental Management.

•Familiarize yourself with the invasive species by requesting a free color guides.

You Can Make a difference!

Algal Blooms

- Algae are microscopic plants that grow naturally in lakes and ponds but are able to adapt to a wide range of conditions including oceans, rivers, ponds, deserts and hot springs. Algae are photosynthetic, yet lack vascular tissue such as roots and leaves and are considered to be evolutionarily less advanced than higher plants, such as macrophytes. Algae are the primary producers in the aquatic environment and provide food and energy for other animals. In addition, during photosynthesis, algae release oxygen into the waterbody.
- Although algae are an important part of the lake ecosystem, their rapid growth can create a condition called an *algal bloom*. Algal blooms can form scum or dense mats on the water's surface and may also affect water color, odor and taste. During an algal bloom, the excess algae die, and the decomposition process consumes oxygen and may result in *anoxic* conditions, which is harmful or fatal to some aquatic animals.
- The most common algal blooms are caused by diatoms and blue-green algae. Diatoms affect the water color, turning it bright green or brown, but rarely create an offensive odor or scum, and may even occur unnoticed. On the other hand, Blue-green algal blooms are rarely undetected. The wind concentrates Blue-green algae into dense, unsightly surface mats, or surface scum, which may wash up on shore and produce a noxious odor as it decays.

What causes algal blooms?

Although there are a variety of reasons for algal blooms to occur, the primary reason is the introduction of excess nutrients, such as phosphorus from fertilizers and detergents, into a waterbody. Storm water runoff, loaded with nutrients generated from a variety human activities, flows over the land or though a storm drain system into a waterbody. Excess nutrients entering the aquatic system allow algae populations to explode. If your lakes experiences algal blooms, it is important to complete a watershed assessment to evaluate land use, soil types, erosion, point sources (such as leaking septic systems) and other possible causes of nutrient loading. The lake's nutrient chemistry, fish population, dissolved oxygen and flow all should be examined as these various factors can also effect the algal population in your lake.

Although an introduction of excess nutrients to the waterbody is usually the culprit, it is not the sole cause of algal blooms. The size of the algal population is also controlled by microscopic herbivores, called zooplankton, which graze heavily on algae and keep the algal population under control. However, zooplankton are in turn eaten by small fish. If the population of small fish in the lake increases, then less zooplankton are available to consume algae and an algal bloom can result.

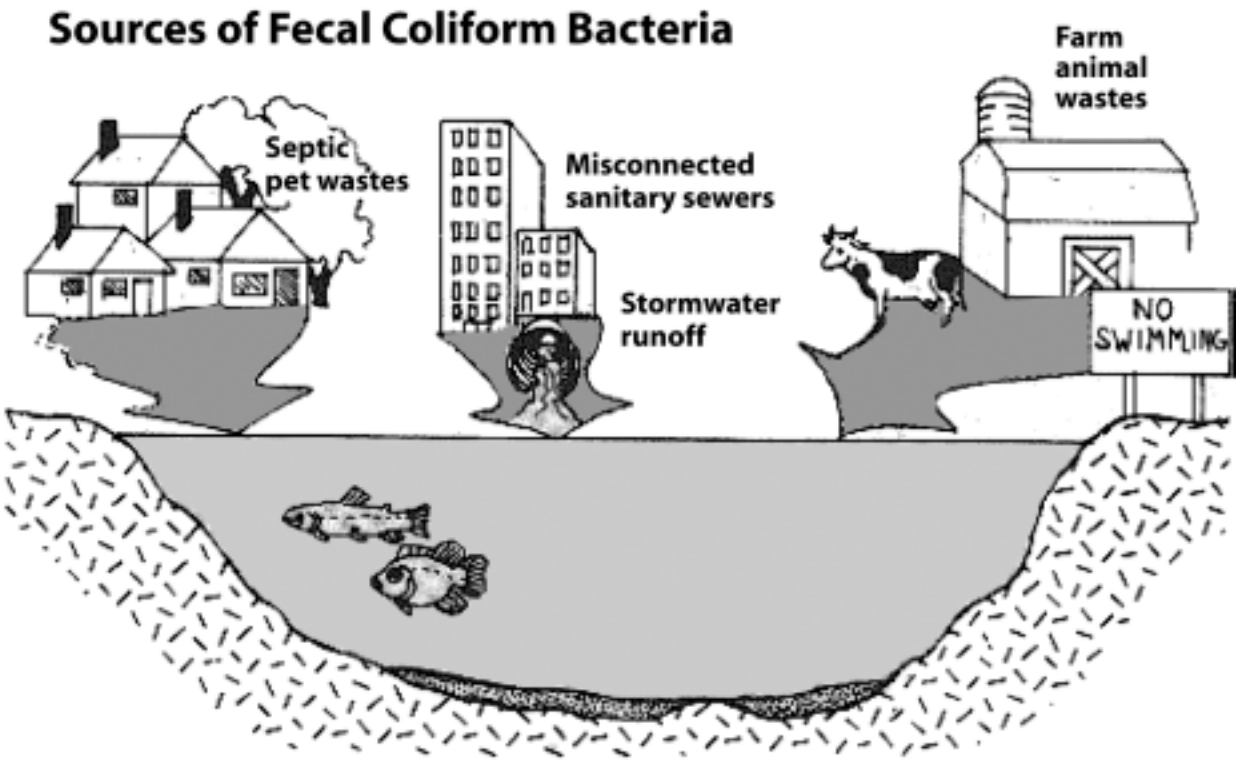
There are many management options for controlling algae, but there is no "quick fix" solution. Reduce the level of nutrients in the watershed is usually the best course of action.

Bacteria

Bacteria are single-cell organisms that live in our environment. Although many are harmless, others are capable of causing serious health problems for humans. The majority of beach closings in Massachusetts are a result of high levels of the type microorganisms that are found in sewage. The state of Massachusetts routinely monitors public swimming areas during the summer, and weekly water tests are performed to ensure that the water conforms to the standards set by the Department of Public Health. If the test fails, then the swim beach is closed until a second test can be completed and the water quality passes.

There are different types of bacteria that contribute to the total fecal coliform count, however, testing water samples for each and every type of disease-causing bacteria is very costly. Samples are only tested for the presence of *E. coli,* a generally harmless type of bacteria that lives in the intestines of all warm-blooded animals including humans, beaver, geese and dogs. Since *E.coli* occurs in high numbers in human sewage it is used as an indicator organism. Large amounts of E. coli indicate a ***possible*** source of contamination from sewage, thus indicating that other disease-causing bacteria could potentially be in the water.

There are many possible sources of fecal coliform, including failing septic systems, farm animal waste, polluted storm water runoff and wildlife (see illustration). Septic systems near waterbodies can fail and release raw sewage into the lake or pond. Runoff from agriculture can also contribute bacteria to the lake. Storm drains may be overloaded after heavy rainfall and overflow, discharging polluted stormwater into nearby lakes and ponds.



If a lake continuously has high *E.coli* counts, other tests are available that examine the genetic material (RNA) of the bacteria to determine exactly which species of animal is responsible for adding the bacteria to the water. By knowing whether to focus on inspecting septic systems, improving storm drains, reducing waterfowl, or addressing agricultural runoff, lake managers are better able to control the bacteria loading to a lake.

Common Lake Issues

Murky Colored Water

During the summer, lake water may turn murky and have an unpleasant odor. The scum looks like blue-green paint and often drifts to the windward shore. This may be an algal bloom. Algae are microscopic plants that are natural components of lakes. Algal blooms are often the result of excess phosphorus (often from lawn fertilizers or other sources) entering a waterbody.

Yellow Green Dust

During the early summer months a yellow dusting may appear on your lake or pond. This dust is likely pollen from nearby pine trees. Over time the pollen will become water logged and sink to the lake bottom.

Dark Oily Cloud

The dark oily cloud may be insect cases left behind from a hatch of aquatic insects. The wind can concentrate the cases along the shore, and as they decompose, an oily sheen forms.

Dead Fish

An occasional dead fish is not cause for alarm. Sometimes anglers release an injured fish or the mid-summer stress due to warm water and disease may be the culprit. If you notice numerous dead fish, especially of more than one species, please contact the Department of Fisheries & Wildlife.

Foam (suds) on the shore

Foam on the shore is often natural and occurs when the surface tension of water is reduced and air mixes with the water, creating bubbles. This natural foam will have an earthy or fishy aroma. Many natural organic compounds are capable of reducing the surface tension of water.

Watershed Controls

What are BMP's (Best Management Practices)?

There are many actions that towns can take that will help reduce the harmful effects of polluted stormwater. BMP's, or best management practices, have been developed for town planers and lake planners to enable them to make wise choices for the lake's future. BMP's are either non-structural, (education, build-out assessments), or structural (installing new systems, creating wet ponds). A few have been listed below but for a complete list contact DEP or NALMS.

Non Structural Best Management Practices

Zoning and Land Use Planning

By studying a town's current demographics, economics, existing natural resources, current land uses and forecasted growth, planners are able to create educated zoning plans and land use controls that will ensure protection of water resources and critical areas. These projects, called build out assessments, include simple steps such as determining minimum lot sizes, creating development plans with the least fragmentation, and determining best land use. These plans will help to insure a healthy future for the lake, town and other fragile resources.

Education

Education is a critical component in any watershed management or town plan, and can be geared towards both municipalities and citizens. Training programs help to introduce stormwater management issues and new design technologies. Development of interactive community programs, including: storm drain stenciling, rain gardens, hazardous waste recycling days, responsible pet clean-up, water conservation education, holding lake friendly home design workshops and promoting phosphorus-free fertilizer rebates help to encourage citizen involvement and convey the message about the value of our water resources.

Non-structural Best Management Practices cont……

Routine Storm Drain Maintenance/Mapping

Routine street sweeping and catch basin cleaning prevents an overflow of sediments and other contaminants into waterbodies. It is also important to have current mapping and ground-truthing of storm drain locations for each town.

Source Reduction

There are many bylaws that towns can adopt to reduce the source of stormwater contaminants, including; reducing road sanding and salting, banning fertilizers and detergents that are high in phosphorus, encouraging recycling of hazardous materials and reducing litter.

Maintain Riparian areas and Buffer Strips

Riparian areas and buffer strips are complex ecosystems established along drainage areas that function to slow/reduce storm water velocity, trap suspended sediments, filter out contaminants, absorb nutrients and reduce erosion.

Site Planning

Unlike watershed planning, site planning is a small-scale approach. The soils, potential land uses, location in the watershed, topography and impacts of the proposed activities are all evaluated as part of the planning or subdivision process. There are several BMP's that can be followed when designing a home, and during construction, that can reduce the negative impacts of stormwater. These may include minimizing the driveway surface area and increasing lawn area.

Preventative Construction Techniques

Protecting exposed soils with tarps and hay bales, careful storage and removal of chemicals or other waste, installing washing areas, protecting storm drains and utilizing secure sanitary facilities will help to prevent stormwater contamination during construction.

Structural Best Management Practices

Structural Best Manage Practices include pre-treating the storm water with a variety of new technologies, filtering, storing and moving storm water, preventing erosion and upgrading existing systems.

Pre-treatment of Stormwater

There are many new designs that can be implemented to improve the quality of storm water before it reaches its destination. Some of these may include paving streets with porous pavement, which allows a greater percentage of water to infiltrate into the soil, thus reducing the volume of runoff and recharging groundwater. Implementing new storm drain designs, including porous French Drains and Infiltration Basins, allow water to slowly filter out into surrounding soils. Dry wells collect runoff primarily from rooftops and direct it into infiltration pipes where it can seep into the surrounding soils rather than rush into storm drains.

Filtration of Storm Water

Sand filters, which allow stormwater to pass through layers of sand that filter out metals, bacteria, sediments and other contaminants, can be added to most storm drain systems to improve the quality of the stormwater.

Transport of Stormwater

Vegetated swales can be constructed along roadsides to collect and filter street runoff.

Structural Best Management Practices Cont….

Settling of Stormwater

Wet ponds are capable of retaining stormwater and later releasing it at a controlled rate, while constructed wetlands detain and treat stormwater before it is released. Both of these reduce the velocity of stormwater, allow it to be filtered and then release it slowly.

Erosion Control

Vegetated natural buffers provide natural protection to sensitive areas by slowing approaching runoff and filtering contaminants. By slowing the velocity of runoff, erosion is decreased and infiltration increased.

Installing New Technological Systems

Many companies have created systems to treat storm water by filtering out grease, sediments and other contaminants. Some of the many available systems include: StormTreat, AquaShield, StormFilter, and Vortechs.

In-Lake Restoration Techniques

Here is some general guidance on solving some common lake problems and some advantages and disadvantages of each. Because each lake or pond is unique, before implementing any method, an initial study should be performed to identify the cause of the problems noted. Most methods require permits and need to be implemented by a professional . For additional information reference the Generic Environmental Impact Report (GEIR).

Method	Advantages	Disadvantages
Aluminate sulfate (alum treatment)	Lowers phosphorus levels. Blocks the release of phosphorus from sediments. Increases water clarity.	May be toxic during application. May be an increase in plant growth due to improved water clarity.
Artificial Circulation	May prevent/disrupt stratification. Increases the levels of oxygen in the water and extends aerobic zone.	May increase turbidity. Will not effect plant/algae growth. May have negative impacts on cold water fish species.
Bio-manipulation (altering the fish community in the lake)	Usually increases the number of zooplankton that eat algae.	Still in experimental stages. Will not reduce blue-green algae.
Dilution (flush the lake)	Removes algae on the surface. Lowers the levels of nutrients.	Requires a large amount of water. Will not effect the inputs phosphorus to the waterbody may have downstream impacts.

In-Lake Restoration Techniques continued…

Method	Advantages	Disadvantages
Dredging	Deepens the lake by removing the accumulated sediments and increasing the water volume. Improves clarity. Removes aquatic plant matter.	Temporarily disturbs the habitat and increases turbidity. May release toxins from sediment .
Hypolimnetic Aeration	Adds oxygen to deep waters. Limits the release of phosphorus from sediments.	May cause destratification. Will not control macrophytes. May cause algal blooms.
Water Drawdown	A control technique for macrophytes. Allows for dock repair/maintenance. May improve shores and beaches.	Negative impact on fish and other organisms. Not ideal for some climates. May have negative impact on out flowing streams due to reduced water flow.

Plant Removal Techniques

Method	Advantages	Disadvantages
Manual Methods (hand pulling, cutting)	Inexpensive and non-toxic. Affects only the target plant species. Does not harm beneficial plants.	Not practical for very large areas. Need divers for deeper waters. Labor intensive. Stirs up sediment.
Benthic Barriers (bottom covers)	Restricts upward plant growth. Limits light to lake bottom. Good for small areas near docks or beaches without effecting the rest of the waterbody. Non-toxic.	Harmful to benthic community. Accumulated sediments must be removed. Need to inspect often. May be damaged by anchors. Must anchor securely as gases may cause the barrier to float up.
Mechanical Cutting (clipping plants below the water surface)	Inexpensive. Immediate results. Targets one area of the waterbody. Fairly species specific. Non-toxic.	May cause plant fragments which can re-grow. Roots may re-grow. Must do several cuts each season. Not species specific.
Mechanical Harvesting	Removes all plants from the area.	Labor intensive and expensive. Does not target specific plants. Plant fragments may re-grow. Can only cut up to 5’ below surface.

Plant Removal Techniques cont…

Hydro-raking	Removes plant roots. Removes all plants from the area.	Disturbs sediments which negatively impacts bottom dwellers, increases turbidity, and may release nutrients and toxins from sediments. Causes fragments which may re-grow.
Biocontrols (weevils)	Species specific and non-toxic. Potential for long term control.	Will not remove all the plants. Expensive. Slow response.
Herbicides	Very effective and ideal for large areas. May be used to spot treat specific plants.	May harm beneficial plants. Decomposing plant matter may release nutrients and decrease oxygen levels in the water. Recreational activities may be temporarily restricted.
Drawdowns	Non-toxic and works on most plants.	May be an inconvenience for dock owners. Not species specific and may affect other organisms. Weather conditions may alter effectiveness/feasibility. May affect out-flowing streams and wells.

Actions You Can Take to Protect Your Lake

- Creating a Lake Friendly Home
- How and Why to Start or Join a Lake Group
- How to Obtain Funding for Your Lake
- Laws That Protect Your Lake

Thoughtful Landscaping

If you reside on lakefront property, use environmentally friendly landscaping techniques to prevent sedimentation and pollution.

- If possible, build homes where the land has the gentlest slope.
- Leave as much vegetation on slopes as possible to reduce the velocity of run off and to filter out sediments.
- Create the greatest possible buffer along the shoreline (a minimum of 30’ is recommended) by leaving existing vegetation and rocks or by planting small shrubs. This buffer will reduce the effects of storm water runoff and erosion from waves and deter geese from the lawn, while still providing a view of the lake.
- Develop a winding dirt path to your shore or dock. The reduced slope of a winding dirt path generates less erosion and run off than a steep paved path.
- Do not add sand to your beach area; introduced sand is a major source of sedimentation and phosphorus.

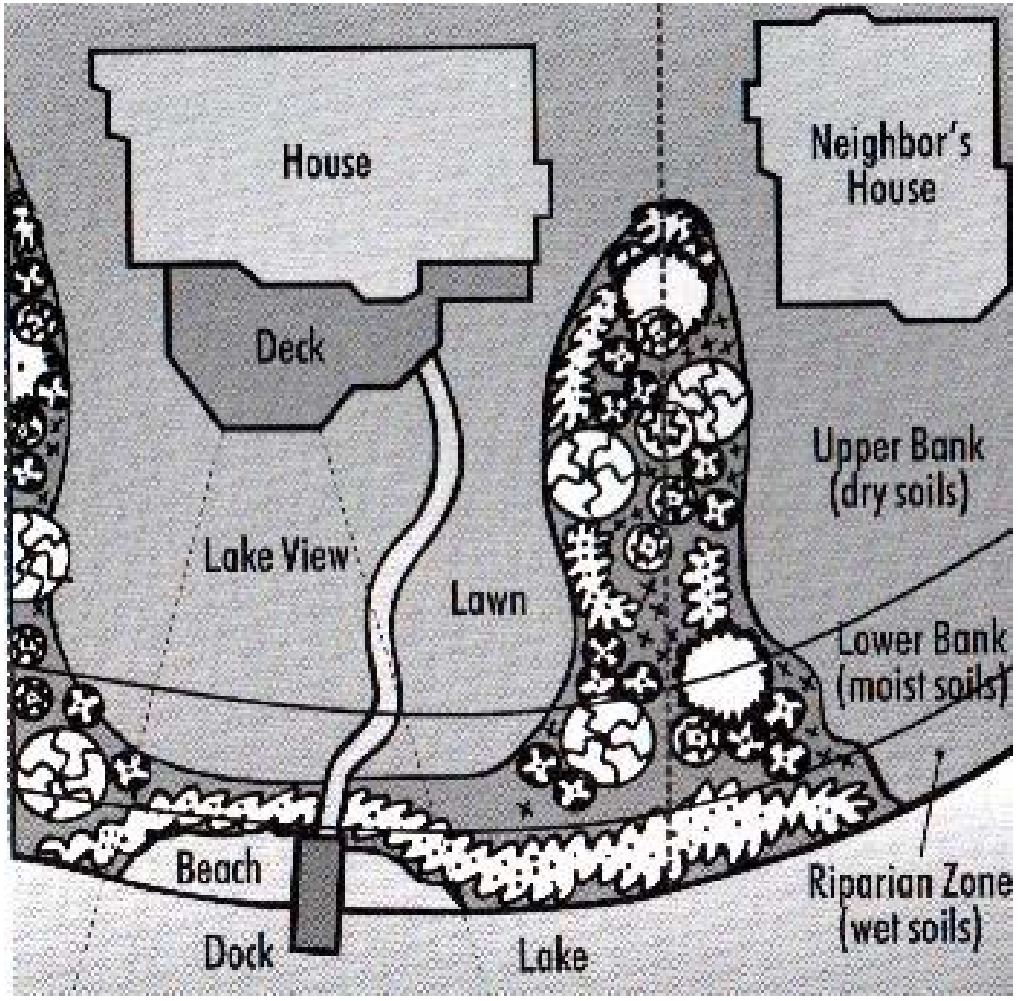
Thoughtful Landscaping cont…

- If you plan to do construction in an area where the soil will be left unprotected, use hay bales and fabric fences to hold the soil in place. Mulch disturbed areas just prior to the final grading.

- Improve your driveway so that stormwater is diverted through u-shaped gravel or vegetated ditches that are designed to filter sediments and nutrients.

- Work with your town to improve drainage from town roads and parking lots.

- Direct run-off towards wooded areas so sediments, toxins and nutrients can be filtered out. Work towards a goal of zero runoff from your property.



Reduce Phosphorus

Reduce the level of phosphorus that is released into the watershed and/or lake.

- Carefully read the levels of phosphorus in cleaning products and make wise choices. If the code on the packaging begins with ”O” then there is less than 0.5% phosphorus, however, if the code begins with a ”P” the phosphorus content is higher. (All, Bold, Arm and Hammer, Green Mark, Cheer, Dash, Bright Water, Surf, Whisk, Shop n' Save have less than 0.5%)
- Perform a lawn test in the spring to determine if fertilizer is needed, before applying. For information visit: www.umass.edu/plsoils/soiltest
- Do not fertilize or use herbicides prior to or just after any precipitation because stormwater runoff may carry the phosphorus and toxins to the lake.
- Select plants that require little fertilization and spot treat with liquid fertilizer only as needed. To determine the phosphorus content in the fertilizer, read the middle number in the formula on the package. For example: 16 **4** 8. Four is the phosphorus content.

Maintain Your Septic Tank

- Conserve water and reduce the burden on your septic system by fixing leaking faucets. Choose Commercial drain cleaners carefully as many may be harmful to the groundwater and to your leach field.
- Monitor the levels of sludge in the septic system and have the tank cleaned when it reaches half full. When septic systems are not pumped routinely, the leach field may become clogged.
- Bleach, drain cleaners, chemicals, and paints harm beneficial microorganisms in the septic system. Paper towels, cigarettes and garbage disposal debris should never be flushed as these products can overload the septic system.

Reduce Hazardous Materials

Consumer products such as paints, paint thinners, solvents, batteries, and household cleaning products are hazardous materials and need to be disposed of properly. Many of these products cause cancer and once released into the environment, will remain there for many years.

•Seek alternatives to hazardous cleaning products and reduce the use of heavy metals.

•Store hazardous materials in approved containers, in a safe location, and check for leaks.

•Never dispose of oil or gasoline on your driveway or street. Many gas stations recycle batteries and oil.

•Dispose of solvents and paint thinners responsibly because these products are toxic to the environment and are not biodegradable. Watch for a **Hazardous Waste Disposal Day** or encourage your town to hold one.

•Do not purchase mercury thermometers. Mercury is very toxic and exposure can cause hearing, memory or vision loss, paralysis, psychological effects, kidney problems and at high doses, death. Mercury can cause congenital malformations, and pregnant women can pass mercury along to their child after eating contaminated fish. If you own a mercury thermometer, learn about disposal and trade-in options. (see contacts on back inside cover)

Reduce the Use of Pesticides

- Pesticides can be harmful to the environment so always follow safety precautions.

- Refrain from using pesticides during or after a storm and do not discard left over pesticides down drains or on the ground; always dispose of properly.

- Rake as little as possible because leaf litter will help to soak up toxins.

Alternatives to Pesticides

- Marigolds help repel asparagus beetles
- Pour beer or vinegar in a shallow pan to attract and trap snails and slugs
- Bacterial spray can be used to kill gypsy moths during their larval stage
- Cockroaches can be removed with a 1:1 powered sugar and boric acid mix sprinkled along baseboards and in corners. Make sure that no water is available for the cockroaches to drink.
- If you do need to use pesticides, check suggested websites.

Select Native Plants

Native plants are ideal for landscaping lakeshore homes, and are often more disease resistant and hardier than their exotic counterparts and thus require less pesticide and fertilizer. Many native plants are a good source of food for wildlife and will enhance bird watching and other activities. For a brochure on Landscaping with Native Plants contact the New England Wildflower Society

Selected Aquatic Alternatives

Exotic	Native Options
Fanwort (*Camomba caroliniana)*	Water Buttercup (*Ranunculus*) Water Marigold (*Megalodonta)*
Water Milfoil (*Myriophyllum ssp.)*	Coontail (Ceratophyllum)
S.American Waterweed (E*geria densa)*	Native Waterweed (*Elodea*)
Hydrilla *(Hydrilla)*	Coontail (Ceratophyllum)
Yellow Water Lotus (*Nelumbo lutea*) (native but highly invasive plant)	White Water Lily (*Nymphaea odorata*)
Purple Loosestrife (*Lythrum salicaria)*	Gayfeather (*Liatris spicata*), Cone Flower (*Echinacea purpurea)* Willowherb (*Epilobium angustifolium*)

Many species, native or non-native, can become invasive when they are released into a waterbody. Never dispose of aquarium or water garden plants or animals into a waterbody. In addition, use caution when selecting plants because suppliers often advertise species by a variety of names. Bring a guide with you to the store for accurate identification.

Starting a Lake Group

If you live on or near a lake, starting a lake group is a good first step towards protecting your lake's future and resolving problems that are currently threatening your lake 's health. Although one person working alone can make a difference, a group of people with similar concerns and interests have a much larger voice and can have a greater impact. Members of a lake association meet to discuss lake issues and determine courses of action to protect their lake. You and your neighbors can:

- Attend town meetings to be a voice for your lake,
- Apply for grants to protect or improve your lake,
- Monitor your lake or pond for invasive species and to check water quality,
- Work with the towns to address watershed issues including increased cleaning of storm drains, implementing new storm water control techniques,
- Work with planning boards to reduce the impact of increasing development,
- Attend workshops to gain more knowledge about lake ecology, hydrology etc., and
- Hold training workshops to educate the community about lake and watershed issues

The Congress of Lakes and Ponds (COLAP) is an organization that provides guidance to lake and pond associations. They can assist you in developing an association and provide opportunities for training, networking and support. Email: Hildrethcr@aol.com Website: www.colap.com

Guidance Material

Starting a Lake Association
To request a brochure (free) contact UW-Extension, Lakes Management Program, College of Natural Resources, Un. of Wisconsin, Stevens Point WI 54481 or call 715-346-2116

Citizen Monitoring
To order send $5.00 to NALMS P.O. Box 5443 Madison, WI 53705 or call 608-233-2836

Handling Conflicts on Your Lake
Write Ecovision Associates 76 E. Sherwood Road, Williamstown, MI 48895-9435
or call 517-347-2652

In Current Repair
To order send $15.00 to Dane County Lake and Watershed Commission 210 Martin Luther King Blvd. Room 421, Madison WI 53709 (video about non-point pollution)

Your Lake and You
NALMS PO Box 5443 Madison, WI 53705 5443 email:nalms@nalms.org
or visit the web at www.nalms.org

Lake Line
NALMS PO Box 5443 Madison, WI 53705 5443 email:nalms@nalms.org
or visit the web at www.nalms.org

Managing Lakes & Reservoirs
NALMS PO Box 5443 Madison, WI 53705 5443 email:nalms@nalms.org
or visit the web at www.nalms.org

Funds For Your Lake

State Grants

Department of Environmental Protection Grants

319 Nonpoint Source Grant Program

This grant program focuses on projects that implement measures that address the prevention, control and abatement of non-point pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; have a 40 percent non-federal match of the total project cost; contain an appropriate method for evaluating the project results; address activities that are identified in the Massachusetts NPS Management Program Plan.

- RFR: are typically issued by the DEP each February.
- Who Can Apply: Any interested Massachusetts public or private organization.
- Contact: Department of Environmental Protection
  627 Main St. Worcester, MA 01608

Source Water Protection Technical Assistance/ Land Management Grant Program

This grant provides funds to third party technical assistance organizations that assist public water suppliers in protecting local and regional ground and surface drinking water supplies.

* RFR: are issued each program year.
* Who Can Apply?: Third party organizations that have experience providing technical assistance related to drinking water protection.
*Information available: www.state.ma.us/dep/brp/dws/dwspubs.htm or www.comm-pass.com

University of Massachusetts

Massachusetts Water Watch Program

The Massachusetts Water Watch Partnership (MassWWP) provides training and other technical assistance to citizen organizations who conduct water quality monitoring programs on the lakes, rivers, and estuaries of Massachusetts.

For information visit: http://www.umass.edu/tei/mwwp/

Federal Grants

Natural Resources Conservation Services

Watershed Protection and Flood Prevention Program

This program works through local governmental sponsors to solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres.

Contact: state headquarters at (413) 253-4350 or www.nhq.nrcs.usda.gov

Laws that Protect your Lake

State Laws

This section summarizes some of the principle state laws that govern lake and shoreland activities in Massachusetts. The information is intended as a general guide only. If you plan to conduct any activities in or near the water you should contact your local conservation commission and the Department of Environmental Protection (DEP) for additional information and permits.

Massachusetts Wetlands Protection Act

The Massachusetts Wetlands Protection Act (WPA) regulates development activity near or affecting wetlands and floodplains in Massachusetts. The WPA exists to promote the following interests:

- protection of public and private water supply
- protection of groundwater supply
- flood control
- storm damage prevention
- prevention of pollution
- protection of land containing shellfish
- protection of fisheries
- protection of wildlife habitat

In general, the WPA reviews and regulates work that may alter a Wetland Resource Area.
These areas include a variety of lands that are affected in some way by water resources such as bordering vegetated wetlands, swamps, marshes, meadows and bogs, banks and dunes. To be protected under the WPA, these resource areas must be land under water or bordering a water body (lake, pond, river, stream, creek, estuary or the ocean).
Activities proposed within one hundred (100) feet of a resource area are also subject to regulation as work within the Buffer Zone.
The WPA's definition of "alter" is broad enough to potentially trigger the regulation of all lake/pond restoration and maintenance projects. Most development impacts are considered an alteration, including changes in drainage, salinity, sedimentation, water flow, flood retention, water levels, water temperature or other characteristics of the receiving water.
Applications (called Notices of Intent or NOI) for permits (called "orders of conditions" or OOC) under the WPA must be submitted to the local conservation commission for review. The NOI provides a complete description of the site and the proposed work.

Common Lake Issues cont….

Green Cotton-like Clouds

Green clouds floating in shallow water may be filamentous algae and their presence does not necessarily indicate a water quality problem. The clouds often occur after heavy run off in the spring or a heat wave in the summer. However, if the algae is found only in specific areas it may indicate a source of local pollution such as a failing septic system or a contaminated stream.

Red Itchy Rash on Swimmers

This rash may be Swimmer's Itch, which is caused by a larval stage of a parasitic fluke, Schistome. When a larva encounters a swimmer it will penetrate the swimmer's skin. The body's reaction to the presence of the larva results in red spots and swelling, similar to a mosquito bite. To avoid Swimmers Itch try a liberal application of suntan oil prior to entering the water, which helps to prevent the fluke from attaching, towel off briskly after a swim, or try swimming in a different area of the lake.

Leeches

These are flat worm-like animals that attach to exposed skin and draw blood. Leeches are found in shallow protected waters and are most active on hot summer days and at night. Leeches are drawn to the disturbances in the water near docks and swim beaches. To avoid leeches, swim in deeper waters off docks and floats.

Resources

- Other Publications
- Lake Contacts
- Useful Lake Links
- Glossary
- References

State Publications

Brochures

Lawns and Landscapes in Your Watershed (DEP)
TMDL's: Another Step to Cleaner Waters (DEP)
Don't Trash the Grass (DEP)
Invasive Plants (DEM)
Shoreline Surveys: Action Tool (DEP)
Clean Rivers Begin at Home: A Guide to Understanding Nonpoint Pollution (DEP)

Manuals and Guides

- Guide to Aquatic Invasive Species (DEM)
- Guide to Aquatic Plants in Massachusetts (DEM)
- Eutrophication and Aquatic Plant Management in Massachusetts (DEP)
- Nonpoint Source Management Manual: A guidance Document for Municipal Officials (DEP)
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planers, Designers, and Municipal Officials (DEP)
- Volume I: Stormwater Policy Handbook (DEP)
- Volume II: Stormwater Technical Handbook (DEP)
- A Guide to Lakes and Ponds in Massachusetts Forests and Parks
- Surveying a Lake Watershed and Preparing an Action Plan (DEP)
- Give Your Lake the Blues! (DEP)

State Publications cont…

Other
Boat Ramp Signs “Stop the Spread of Nuisance Species”
Invasive Species Poster
Waterline (a quarterly guide to watersheds, wetlands waterways, drinking water) (DEP)
Online Lake and Pond Maps http://www.state.ma.us/dfwele/dfw/dfw_pond.htm

Additional copies of DEP Materials can be obtained by calling a Regional DEP Service Center:
Northeast (978) 661- 7677
Southeast (508) 946-2714
Central (508) 792-7683
Western (413) 755-2124
http://www.state.ma.us/dep

DEM materials can be obtained from
Department of Environmental Management
251 Causeway St Suite 700 Boston MA 02114
1-617-626-1382 or 1-617-626-1411
www.mass.gov/lakesandponds

Lake Contacts

Executive Office of Environmental Affairs (EOEA)
251 Causeway St – 9th Floor, Boston, MA 02114 Phone: 1-617-626-1000 www.state.ma.us/envir

Massachusetts Department of Environmental Management (DEM)
251 Causeway St - 6th Floor, Boston, MA 02114 Phone: 1-617-626-1250 www.state.ma.us/DEM
- Lakes and Ponds Program www.mass.gov/lakesandponds

Massachusetts Department of Environmental Protection (DEP)
627 Main St., Worcester, MA 01608 Phone: 1-508-767-2877 www.state.ma.us/dep/

Massachusetts Department of Fisheries, Wildlife & Environmental Law Enforcement
251 Causeway St – 4th Floor, Boston, MA 02114 Phone:1-617-626-1590
www.state.ma.us/dfwele/dfw/dfw_toc.htm
- Natural Heritage www.state.ma.us/dfwele/dfw/nhesp

U.S. Environmental Protection Agency (EPA) New England Region 1
1 Congress St Suite 1100 Boston, MA 02114 Phone:1-888-372-7341 Emergency # 1-800-424-8802
www.epa.gov/OW/index.html

North American Lake Management Society (NALMS)
P.O. Box 5443 Madison, WI 53705-5443 Phone:1-608-233-2836 www.nalms.org

Massachusetts Congress of Lakes and Ponds (COLAP)
135 Washington Street, Holliston, MA 01746 Phone:1-800-845-2769 www.colap.com

Lakes and Ponds Association of Western Massachusetts (LAPA-WEST)
C/O Hampton Ponds State Park 1048 North Road, Westfield MA 01085 LAPAWEST@aol.com

Massachusetts Water Watch Partnership
Blaisdell House- University of Massachusetts
Box 30820 Amherst, MA 01003-0820 Phone:1-413-545-5531 www.umass.edu/tei/mwwp/

Useful Lake Links

U.S Environmental Protection	www.epa.gov
Envirofacts	www.epa.gov/enviro/index.html
Surf Your Watershed	www.epa.gov/surf
Nonpoint Source Homepage	www.epa.gov/OWOW/NPS
TMDL Home page	www.epa.gov/OWOW/TMDL
U.S. Department of Agriculture	
Agricultural Research Service	www.ars.usda.gov
Natural Resources Conservation Service	www.nrcs.usda.gov
Other Sites	
Environmental Information Resources	www.gwu.edu/~greenu/index2.html
National Wildlife Federation	www.nwf.org
U.S. Geological Service	www.usgs.gov
Washington State Lake Book	www.ecy.wa.gov/programs/wq/plants/lakes/walpa.html
Water on the Web (educational site)	http://wow.nrri.umn.edu/wow/under/primer/index.html
Glossary of useful words	www.nalms.org/glossary/glossary.html
Invasive Species Sites	
Center for Invasive & Aquatic & Plants	http://aquat1.ifas.ufl.edu/welcome.html
New England Wildflower Society	www.newfs.org
Aquatic Nuisance Species Panel	www.protectyourwaters.net
Invasive Species	www.invasivespecies.gov/profiles/main.shtml
USGS Non-indigenous Aquatic Species	http://nas.er.usgs.gov/
For More Information	
on Endangered Species	www.state.ma.us/dfwele/dfw/nhesp
on Hazardous Waste Alternatives	www.metrokc.gov/hazwaste/house/cleaners.html
on Hazardous Material Facts	http://environment.about.com/library/weekly/blchem1.htm
on Pesticides	www.pesticides.org

Glossary A-E

Algae: Algae are small, non-vascular (lacking roots and leaves) plants that grow in the water.
Anoxic water: Waters that contain less than 0.5 ml/l of dissolved oxygen. Most aquatic animals can not survive with so little available oxygen.
Blue-green Algae: Although not actually algae, they are often indicators of high phosphorus concentrations in the water.
Algal Bloom: An algal bloom is the burst of algae growth that can result in scum on the water surface, odor, color or taste changes and decreased oxygen in the water.
Aphotic Zone: Zone where there is insufficient light for photosynthesis, so plants can not survive.
Benthic Communities: The diverse group of animals (including snails, leeches, and some stages of insects) that live in the lake bottom and have a major role in the decomposition of organic material.
Best Management Practices: BMP's are practices that minimize the impact from non-point source pollution including logging, stormwater run-off, construction and agriculture.
Buffer: Trees, shrubs, grass and other plants that lie between a body of water and an area of development. The vegetation helps to absorb nutrients, slow stormwater run-off and reduce sedimentation.
Circulation: The season mixing of layers of water in a lakes or ponds of adequate depth. Often referred to as spring turnover or fall turnover.
Dissolved Oxygen: (DO) Refers to the amount of free oxygen dissolved in the water. Low levels of DO can be harmful to fish and other animals.
Ecosystem: This is a spatial unit including the relationship between living things, and their abiotic environment including one another.
Erosion: The gradual removal of rock or soil particles through the actions of weather (wind, water, and ice) or human activities.
Erosion controls: Methods developed to reduce erosion during human activities. Hay bales, silt fencing, and mulching buffers are all physical barriers that help prevent erosion.
Exotic Species: An exotic species is a species that has been introduced to a new region. Since the species did not originate in the area, it often does not have natural control agents (ex. disease) and may spread rapidly and disrupt the ecosystem.

G- O

Groundwater: Water that travels or is stored beneath the surface of the earth, yet occasionally discharges into lakes, streams or the ocean.
Habitat: An area where animals can find suitable shelter, food and are able to reproduce and live.
Impervious Surface: A surface, such as pavement or rooftops that limit or prevent water from entering and being filtered by the soil. These surfaces disrupt normal groundwater recharge, increase the amount and velocity of run-off, heat the run off and alter natural hydrological flows.
Invasive Species: A species, native or non-native, that is able to spread rapidly and alter or dominate an ecosystem.
Lake: There is no real definition of a lake. Generally speaking, lakes are mixed primarily by wind action, tend to be deeper, have unlit bottom waters, rooted aquatic plant growth only in the lake's margins, and in New England they usually become thermally stratified in the summer.
Lake Ecology: The study of the relationship between living things and the lake environment.
Limiting Nutrient: A nutrient, such as phosphorus, required by plants to grow, that is relatively rare in the environment. Therefore, its availability determines the amount of plant growth.
Limnologist: A person who studies fresh water ecology. Limnologists work on lake management, restoration, pollution control and other issues.
Littoral Zone: The area extending from the shore to the maximum depth of plant growth.
Macrophytes: Vegetation with vascular tissue; considered evolutionarily "higher" than algae.
Nonpoint Source Pollution: Pollution that enters a waterbody from a variety of sources, including stormwater, wildlife influences and recreational activities. Nonpoint source pollution does not come from a specific identifiable source, such a pipe or drain.
Nutrients: Nutrients are substances, including nitrogen (N), phosphorus (P) and carbon (C), that are required for the survival of plants and animals.
Oligotrophic: A term that describes a lake that is not very productive, low in algae and nutrients, usually has clear waters and, if stratified, has adequate oxygen in the lower layer.

P - S

Pelagic Zone: describes “open waters” that do not have contact with the shore or lake bottom.
pH: pH describes the acidity of water on a exponential scale of 1-14. A range of 0-7 is acid, 7-14 is alkaline. A pH of exactly 7.0 is neutral. Derived from a French word meaning “strength of the hydrogen”
Phosphorus: This is a nutrient that is required by all living organisms. Phosphorus is found naturally in the environment and also in fertilizers and sewage.
Photic Zone: The sunlit upper waters that extend from the surface to the point where light dims to 1% of that at the surface.
Photosynthesis: The process by which plants and some other organisms convert carbon dioxide to sugars and oxygen, using the sun’s energy and chlorophyll.
Point Source: Pollution that can be traced to a specific source such as a pipe.
Respiration: The process that utilizes oxygen to convert food molecules, such as glucose, into energy, water and carbon dioxide.
Run-off: Run-off is the water from rain or melting snow melts that runs downward over the earth’s surface. Stormwater run-off is often considered a key source of nonpoint pollution.
Secchi Disk: The Secchi disk is a simple tool used to measure water transparency. The black and white disk is lowered into the water to the point where it is just visible and the depth is recorded.
Sediment: Particles of minerals and organic soil that are carried from one place to another by wind, glaciers and flowing water.
Shoreline Erosion: The loss of soils along a shoreline into the lake. This is often accelerated by the removal of vegetation near the shore that held soils in place.
Succession: the natural process of a lake from nutrient poor to increasingly productive and nutrient rich. Under natural conditions, this process can take thousands of years to occur.

S - T

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Temperate (lake): Lakes that are located in a climate where the summers are warm and the winters relatively cool. This zone extends between the Tropic of Cancer to the Arctic Circle.
Thermocline: The zone of rapid temperature change that creates a physical barrier to mixing. It creates the seasonal upper and lower layers of water in lakes with adequate depth.
Transparency: Describes the clarity of water. When many soils or organic particles are clouding the water, turbidity is increased.
Turbidity: Describes that clarity of water. The presence of suspended matter in the water reduces transparency

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EPA 1996 *Guide to Environmental Issues*

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Washington State Department of Ecology

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(line drawings of Curly-leaved Pondweed, Common Reed, Variable Milfoil, Hydrilla and Water Chestnut.)
King County web site http://dnr.metrokc.gov/wlr/waterres/smlakes/weed.htm
(line drawings of Fanwort, Eurasian Milfoil and Purple Loosestrife)

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